DEC 16 1924

PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

ENGINEERING:

An Illustrated Weekly Journal.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXVIII.—No. 3075.] LONDON: FRIDAY, DECEMBER 5, 1924. [Registered at the General Post Office as a Newspaper.] [PRICE ... 1s. BY FOREIGN POST 1s. 4d.

Aveling & Porter, Ltd.,
ROCHESTER.
Steam & Crude Oil Road Rollers, &c.
1869

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
OF ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See Advertisement page 34.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

E. J. Davis, M.I.Mech.E.,
Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1738 & 1737. Wire: "Rapidising London." —Great Eastern Road, Stratford, E. 15. 1794

Spencer-Hopwood & Kirke
PATENT BOILERS. *See page 49, Nov. 28.* 1694
Sole Makers: SPENCER BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1948

See's Patent Hydro-Pneumatic Ash Ejector
Great saving of labour. No noise. No dust. No dirt. Ashes discharged 20 ft. clear of vessel.—Apply, F. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 43, Billiter Bldgs., Billiter St., London, E.C. Od 4835

New Wire Ropes,
Half price.
LONDON ELECTRIC FIRM,
Croydon. 2430

Chain & Rope Blocks
(OF ALL KINDS).
FELLOWS BROS., LTD., CRADLEY HEATH, STAFFS. 9158

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 1864

Yorkshire Engine Co., Ltd.,
Meadow Hall Works, Sheffield,
Railway, Colliery, Mining and General Engineers, are PREPARED
to UNDERTAKE the MANUFACTURE of NEW SPECIALITIES
suited to their plant and tools.
No financing of patents. Only serious business entertained.
Address confidential enquiries to the SECRETARY. 2404

Steam Hammers (with or without guides). Hand-worked or self-acting TOOLS for SHIPBUILDERS & BOILERMAKERS
DAVIS & PRIMROSE, LIMITED, LEITH, EDINBURGH. 1914

Bever, Dorling & Co., Ltd.,
BRADFORD.
HIGH-CLASS ENGINES FOR ALL PURPOSES, also WINDING, HAULING, AIR COMPRESSING and PUMPING ENGINES. 1896
GOLD MEDAL—INVENTIONS EXHIBITION—AWARDED

Duckham's Patent Suspended
WEIGHING MACHINES—EAST FERRY ROAD ENGINEERING WORKS COMPANY, LTD. LONDON, E.—Hydraulic Cranes, Grain Elevators, &c.
See illus. Advt. last week, page 17. 2420

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 1857

Telegrams:—"Cylinders," Birmingham.
Weldless-Steel Tubes
for Water-tube Boilers, Superheaters, Stanfing Hydraulic Work, Boring Rods, &c.
TUBES LIMITED, BIRMINGHAM. O8179

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 2276

Campbells & Hunter, Ltd.
SPECIALISTS IN
Drillers & Boring Machinery
for Engine Works and Boiler Shops.
DOLPHIN FOUNDRY, LEEDS. 4547

VOSPER & Co., LTD.,
PORTSMOUTH.
SHIP & LAUNCH BUILDERS, Od 3551
ENGINEERS & BOILER MAKERS.

For Your Repairs or any
SPECIAL MACHINERY, try
THOMAS HUNT & SONS,
Albion Ironworks,
Bridge Road West, Battersea, S.W.11.
Est. 1854. 2487

The Mitchell Conveyor and
TRANSPORTER CO., LTD.,
CONTRACTING ENGINEERS,
DESIGNERS and BUILDERS
of
all Classes of HANDLING MACHINERY.
Atlantic House,
45-50, Holborn Viaduct,
London, E.C. 1.
Telegrams: "Micontraco, Cent, London."
Telephone: Holborn 3322. 2418

Dredging Plant—
For ALLUVIAL GOLD, PLATINUM & TIN, HARBOUR, RIVER & CANAL.—Gravel Dredgers, SCREENS.—DREDGE BUCKETS & Parts, all sizes.
ARTHUR R. BROWN,
54, New Broad Street, London, E.C.2.
Telephone: London Wall 3418. 1814

RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.,
THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Od 3383

For Sale or to Feu in Whole
OR PLOTS.
68 ACRES OF GROUND AND BUILDINGS, suitable for works, at Inchinnan, on the main road between Glasgow and Greenock.
One building, length 350 ft. by 150 ft., height 48 ft. to eaves, structure of brick and steel, lit from roof, contains approximately 37,500 sq. ft. floor space.
One building, in several bays, 330 ft. long at the longest part 258 ft. broad, height one part 24 ft. 6 in. to eaves, other part 16 ft. to eaves, structure of brick and steel, lit from sides and roofs, granolithic floors, mechanically heated, contains approximately 83,000 sq. ft. floor space.
One building 320 ft. long by 160 ft. broad, height, 16 ft. 9 in. to eaves, with small annex 50 ft. by 30 ft. structure of brick and steel, granolithic floors, lit from sides and roof, mechanically heated, approximately 53,000 sq. ft. floor space.
Electric power is laid into each of these buildings from the Clyde Valley Power Station, also water supply.
For further particulars apply to:—
WEARING & MARTIN, Writers, 180, Hope Street, Glasgow. 2346

Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement page 33.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM and GAS KETTLES } Row's Patents.
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

IRON & STEEL
Tubes and Fittings
AND
Steel Plates.
STEWARTS AND LLOYDS, Ltd.
GLASGOW - BIRMINGHAM - LONDON.
See Advertisement, page 27. 1872

Cement—Maxted & Knott,
Ltd., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest references. Established 1890.
Address, BURNETT AVENUE, HULL.
Cablegrams: "Energy, Hull." 1838

James D. Roots.—Patents,
BRITISH and FOREIGN. Moderate charges, Long and varied practical Engineering experience valuable to inventors. Formerly many years contributor of Patents Abstracts for "The Engineer" & "The Times."—Thanet House, Temple Bar, London, W.C.2

THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS. PRESSED STEEL WORK OF ALL KINDS. Od3382
Reg. Office and Chief Works: Motherwell. London Office: 32, Great St. Helen's, Bishopgate, E.C.3.

Regent Guillotine Shears and Power Presses
FOR SHEET AND PLATE WORKING.
THE REGENT SHEET METAL MACHINE TOOL CO., LTD.,
REGENT WORKS, WAKEFIELD. 2015

300/350 I.HP. Corliss VALVE CROSS COMPOUND CONDENSING ENGINE, by Burnley Ironworks.
Cylinders 14 in. and 28 in. by 36 in. stroke.
Corliss valves to inlet and exhaust of both cylinders.
Belt Flywheel 16 ft. by 26 in.
Vertical Air Pump and Condenser, below floor level.
Worked by L. Crank from L.P. Crosshead.

120 I.HP. CORLISS VALVE TANDEM COMPOUND ENGINE, by Sharples.
Cylinders 11 in. and 20 in. by 30 in. stroke.
Corliss valves to inlet and exhaust of both cylinders.
Rope Flywheel, 12 ft. dia.
Second motion pulley, 6 ft. diameter.
THOMAS MITCHELL & SONS, LTD.
BOLTON. 2405

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, LEADENHALL ST., E.C.3.
Works: BURNT MILL, near HARLOW, ESSEX.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery,
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers,
&c., &c. 2327

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS. 2277

John Bellamy Limited
MILLWALL, LONDON, E.
GENERAL CONSTRUCTIONAL ENGINEERS. 1216
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Head, Wrightson & Co.,
LIMITED.
See Advertisement page 56, Nov. 28. 2402

Bargains from Bolton.
VERY FINE 18 in. CENTRES S.S. and S.C. LATHE, by Stirk. On 23 ft. bed. All geared headstock. For Motor drive.
34½ in. VERTICAL BORING AND TURNING MILL, by Webster and Bennett.
SEVERAL EQUAL NEW 36 in. D.G. PILLAR DRILLS, by Redman. Rise and fall tables, 2½ in. spindles, etc.
2 CWT. MASSEY TYPE SELF-ACTING STEAM HAMMER.
THOMAS MITCHELL & SONS, LTD.,
EDGAR STREET, BOLTON. G 453
Telephone 302 (Three Lines). Telegrams "Realise."

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED,
DARLINGTON. 2006

WAYGOOD-OTIS LIFTS 2130
54 & 55, FETTER LANE, LONDON, E.C.4.
62 & 63, LIONEL STREET, BIRMINGHAM,
and Principal Provincial Cities and Abroad.

New 530 B.HP. M.A.N. STATIONARY DIESEL ENGINE with accessories, as delivered from the makers under Peace Treaty, £2500; also Dynamo for same, seen London; also other sizes.—HICK-DIESEL OIL ENGINES LTD., 70, Queen Street, E.C.4. 2043

PROPELLERS
AND PROPULSION PROBLEMS.
Special designs only.
"Circulation Theory."
Akimoff Propeller Company,
PHILADELPHIA, U.S.A. 2349

P. & W. MacLellan, Ltd.,
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF
RAILWAY CARRIAGES AND WAGONS
OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, Glasgow. Od 3547
Registered Offices: Clutha House, 10, Princes St., Westminster, S.W.1.

2-500 Kw., 500/550 Volt D.C.
GENERATING SETS, Totally Enclosed, Three Crank Self-Lubricating Engine, with Complete Condensing Plant, by Allens, Pipes, Valves, Oil Separator, Etc., complete.
Admirably suited for Mining or other power transmission work.
JENNINGS,
West Walls,
Newcastle-on-Tyne. 2402

The Manchester Steam Users ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by SIR WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

The Committee of Management

of the BENEVOLENT FUND of THE INSTITUTION OF CIVIL ENGINEERS Hereby Convene an EXTRAORDINARY GENERAL MEETING of the Contributors to the Fund, to be held at The Institution, Great George Street, Westminster, S.W.1, at three p.m., on Monday, the 15th December, for the purpose of appointing a Trustee of the Capital, in the place of the late SIR MAURICE FITZMAURICE, C.M.G. G 584

Correspondence Courses for

Inst. Civil Engrs., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.) Inst. M. & Cy. E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition. — For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1993

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 233, Oxford Road, Manchester. 2431

TENDERS.

THE GREAT INDIAN PENINSULA RAILWAY COMPANY, 48, Copthall Avenue, London, E.C.2, invite

Tenders for :—

1. MISCELLANEOUS ARTICLES & MATERIALS. Fee, 5s. 0d.

Tenders are due by Eleven a.m. on 16th December, 1924. Tender forms obtainable at above address. Fees not returnable. G 611

The Director-General,

INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E.1, requires
BUFFERS AND PLUNGERS AND SOCKETS for Buffers and Railway Wagons.
Tenders due on the 16th December, 1924.
Tender forms obtainable from above. G 605

EDMONTON URBAN DISTRICT COUNCIL.

EXTENSION OF SEWAGE DISPOSAL WORKS.

TENDERS FOR CAST-IRON PIPES.

The Edmonton Urban District Council invite

Tenders for the Supply and

DELIVERY of about 700 tons of CAST-IRON PIPES and SPECIALS in sizes varying from 48 ins. to 6 ins. diameter.

Copies of the Specification, Quantities, Drawings and Form of Tender may be obtained from the Office of the Engineer and Surveyor, CUTHBERT BROWN, M.B.E., M.Inst.C.E., Town Hall, Edmonton, on and after Thursday, December 4th, 1924, upon payment of a fee of £3 3s., which will be returned upon receipt of a *bona fide* Tender and the return of all documents.

The Council does not bind itself to accept the lowest or any Tender. Sealed Tenders endorsed "Tender for Cast-Iron Pipes" are to be delivered at my Office not later than Twelve o'clock noon on Monday, December 15th, 1924.

CUTHBERT BROWN, M.B.E., M.Inst.C.E., Engineer and Surveyor.

Town Hall,
Edmonton,
London, N.9. G 574

EDMONTON URBAN DISTRICT COUNCIL.

EXTENSION OF SEWAGE DISPOSAL WORKS.

TENDERS FOR CLINKER.

The Edmonton Urban District Council invite

Tenders for the Supply and

DELIVERY of about 75,000 cubic yards of HARD FURNACH CLINKER suitable for Bacteria Beds.

The delivery will extend over a period of about 14 months.

All Tenders must be on forms supplied by the Council, which may be obtained with all particulars and information from the Office of the Engineer and Surveyor, CUTHBERT BROWN, M.B.E., M.Inst.C.E., Town Hall, Edmonton.

The Council does not bind itself to accept the lowest or any Tender. Sealed Tenders endorsed "Tender for Clinker" must be delivered at my Office not later than Twelve o'clock noon on Monday, December 15th, 1924.

CUTHBERT BROWN, M.B.E., M.Inst.C.E., Engineer and Surveyor.

Town Hall,
Edmonton,
London, N.9. G 575

BOMBAY, BARODA AND CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 17th December,

Tenders for the Supply of :—

(1) METALS,
(2) WOOD SCREWS, NAILS, SLIT PINS, ETC.

Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: 91, Petty France,
Westminster, S.W.1.
3rd December, 1924. G 603

WIRRAL UNION.
TO ENGINEERS, &c.

Contractors Prepared to Tender

for ENGINEERING WORKS in connection with extensions at the Wirral Poor Law Institution, Clatterbridge, Bebington, are invited to submit their names to the Architects, Messrs. FINCHETT, LANCASTER & ARCHER, Southport, on or before 14th December, 1924.

The work comprises rearrangement of the Well Pumping Plant, Electric Power Plant, and Electric Lighting, Heating, Hot Water Supply, and Cooking Plant, and only Contractors who are prepared to give satisfactory references to similar installations carried out by them will be invited to Tender.

Plans of the Institution will be provided on payment of a deposit of £3 3s. 0d. to be returned on receipt of a *bona-fide* Tender.

D. BUNTING,
Clerk to the Guardians.

54, Hamilton Street,
Birkenhead.
27th Nov. 1924. G 547

METROPOLITAN ASYLUMS BOARD,
TO ELECTRICAL ENGINEERS.
The Board invite separate

Tender for the Installation

of ELECTRIC LIGHTING at Highwood Hospital for Children, Brentwood, Essex, in accordance with the Specification and Drawings prepared by Mr. T. COOPER, M.Inst.C.E., M.I.Mech.E., Engineer-in-Chief. The Specification, Drawings, and Form of Tender may be inspected at the Office of the Board, Victoria Embankment, E.C.4, on and after ten a.m. on 4th December, 1924, and can then be obtained upon payment of a deposit of £1 in respect of the work. The amount of the deposit will be returned only after the receipt of a *bona-fide* Tender sent in accordance with the instructions on the Form of Tender and after the Specification and the Drawings have been returned.

Tenders, addressed as noted on the Form, must be delivered at the Office of the Board not later than 2.30 p.m. on 31st December, 1924.

G. A. POWELL,
Clerk to the Board.
G 580

HAYFIELD RURAL DISTRICT COUNCIL.

MELLOR WATERWORKS.

The Hayfield Rural District Council invite

Tenders from Contractors for

PROVIDING AND LAYING about 7¾ miles of 6in., 5in., 4in. and 3in. CAST IRON PIPES, with all necessary Valves, Hydrants and Apparatus, and also for CONSTRUCTING TWO MASS CONCRETE TANKS at Hayfield and Mellor respectively.

The Drawings and Specifications may be seen at the Office of the Surveyor to the Council at Hayfield, Derbyshire, by previous appointment, or at the Offices of the Engineers, Messrs. G. & F. W. Hopson, M.Inst.C.E., M.Cons.E., Bank Chambers, Loughborough, from whom copies of the Schedules of Quantities may be obtained on deposit of Cheque for £5 5s., which will be refunded to Contractors making a *bona fide* Tender, on the return of the documents to the Engineers.

Sealed Tenders on the form supplied, endorsed "Tender for Mellor Waterworks," are to be sent to the undersigned not later than Monday, the 15th day of December, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

J. R. BOWDEN,
Clerk to the Council.

Council Offices,
High Street, New Mills,
via Stockport.
17th November, 1924. G 447

TAF FECHAN WATER SUPPLY BOARD.
TENDERS FOR STEEL PIPES, VALVES, &c.
The Taf Fechan Water Supply Board are prepared to receive

Tenders for the Supply and

DELIVERY at certain railway stations in South Wales of about 5000 tons of STEEL SOCKET and SPIGOT PIPES of diameters ranging from 37 in. to 17 in., together with certain CAST IRON PIPES, VALVES and SPECIALS, all of British material and manufacture. Though lap-welded steel pipes are specified, Tenderers are at liberty to offer other makes of steel pipes, but riveted pipes will not be accepted. Drawings may be seen and Specification and Form of Tender obtained at the offices of Sir ALEX. BINNIE, SON & DEACON, 30, Buckingham Gate, Westminster, S.W.1, on payment of a cheque for £5 made out to the Taf Fechan Water Supply Board, which amount will be returned on receipt of a *bona fide* Tender. Sealed Tenders, endorsed "Tender for Steel Pipes, Valves, &c.," should be delivered at my office at or before Noon on Tuesday, the 23rd day of December, 1924.

The lowest or any Tender will not necessarily be accepted nor will any expenses in connection with Tendering be defrayed. No Tenders will be considered except from actual manufacturers capable of supplying the pipes at the rate of 600 tons per month, together with a proportionate number of valves and specials.

J. COLENSO JONES,
Clerk to the Board.

Board's Offices,
101, High Street,
Merthyr Tydfil.
1st December, 1924. G 556

APPOINTMENTS OPEN.

DIRECTOR OF RESEARCH FOR CHILEAN NITRATE INDUSTRY.

The Association of Producers of Nitrate of Soda in Chile intends to organise a Central Research Department in that country.

A Director of Research,

Salary £30 0 per annum, and TWO SUB-DIRECTORS, salaries £2000 each, per annum, are REQUIRED.

The appointments will be for three years in the first instance.

Chemists, or Chemical Engineers, with first-class scientific training and successful experience in the scientific investigation, design, and operation of large scale processes and plant are wanted for these posts.

Applicants should be if possible, between 35 and 45 years of age. No previous knowledge of Spanish is required. For further particulars, apply to:—

THE SECRETARY,
THE CHILEAN NITRATE COMMITTEE,
Friars House, G 550
New Broad Street, London, E.C.2.

Assistant Lecturer.—Wanted,

by Faraday House Electrical Engineering College, an ASSISTANT LECTURER in Mathematics and Physics or Chemistry. An engineering graduate preferred. Commencing salary £250 per annum.—Apply by letter in first instance, to Dr. A. RUSSELL, Faraday House, Southampton Row, W.C.1. G 583

SOUTH STAFFORDSHIRE WATERWORKS COMPANY.

MECHANICAL DEPARTMENT.

Applications are Invited for

an Experienced MECHANICAL ENGINEERING ASSISTANT. Must be a good draughtsman and fully conversant with the design and construction of large pumping units of all types. Applicants having a knowledge of electricity preferred.

Commencing salary £275 per annum, which is subject to deductions under the Company's Superannuation Scheme.

Applications with copies of three recent testimonials should state experience, age and when at liberty, and be addressed to the undersigned, endorsed "Mechanical Assistant."

FRED. J. DIXON, M.Inst.C.E.,
Engineer-in-Chief.

Engineer's Office,
26A, Paradise Street,
Birmingham.
3rd December, 1924. G 618

MINISTRY OF TRANSPORT.

ROADS DEPARTMENT.

TEMPORARY ENGINEERS.

Applications are Invited

for a limited number of TEMPORARY APPOINTMENTS as ENGINEERS at salaries of £300 to £500 per annum inclusive according to the post and to experience and qualifications.

These appointments are in connection with road schemes throughout England and Wales, but there are at present vacancies in London only.

Practical and experienced men with a knowledge of local administration and of modern road and bridge construction are required, and preference will be given to men who have served in His Majesty's Forces.

Applications should be made immediately in writing to the ESTABLISHMENT OFFICER, Ministry of Transport, 6, Whitehall Gardens, S.W.1, stating age, qualifications, experience and references. G 607

Wanted, for Modern Steel

Foundry, METALLURGIST for steel production and Heat Treatment. Experience in Siemens' Bessemer and Electric Furnaces desirable. Apply in first instance to:—

FOUNDRY,
c/o T. G. SHUTTLEWORTH & SON,
Church Street,
Sheffield,

stating experience and remuneration required. G 579

Boiler Inspector.—Experi-

ENCED INSPECTOR WANTED for Water Tube Boilers. State fully, qualifications, experience and salary required.—G 597, Offices of ENGINEERING.

Operation Planning.—

Experienced and Energetic MAN REQUIRED, accustomed to high class steam turbine work. Experience in rate fixing essential. South Midlands district.—Address, G 592, Offices of ENGINEERING.

An Opportunity for a Man

who has ambition, energy, personality and common sense.

One of the oldest established firms of lubricating specialists, with the latest plant and modern organisation REQUIRE the SERVICES of someone having the above qualifications. To a man with an inborn gift of salesmanship who feels he is limited in his present position, a worth while proposition can be offered with unlimited possibilities. All replies will be treated by the Head of the firm in confidence.—Address, Z.B. 187, care DEACON'S Advertising Offices, Leadenhall St., E.C.3. G 601

Wanted, by Ship-Repairing

Company on N.E. Coast OUTSIDE REPRESENTATIVE (Engineer). Applicants must be capable of interviewing superintendents and owners, boarding vessels, fixing up prices for work and arranging for their execution. Only those with experience and ability to obtain orders for this class of work need apply. Permanent progressive position and good remuneration to suitable man. State age and experience.—BOX "E," KIDD'S Advertising Agency, Middlesbrough. G 548

THE MUNICIPALITY OF SINGAPORE.
STRAITS SETTLEMENTS.

CHIEF ASSISTANT GAS ENGINEER.

The Municipal Commissioners of Singapore require a

Chief Assistant Gas Engineer,

age about 30/35, of sound constitution, and unmarried. He must have had a good technical education, a regular training as a Gas Engineer, with general all-round experience, including Carbonising and Water-Gas Plant, both in the design and in the construction of new works and in ordinary maintenance and in distribution.

The appointment will be on agreement for three years with possible extension. The selected candidate must pass a medical examination as to his fitness for service in a tropical climate. A passage will be provided with half-salary during the voyage out.

The salary will be 7440 dollars for the first, 7920 dollars for the second, and 8400 dollars for the third year, paid monthly, the value of the dollar being two shillings and four-pence sterling. For the first year the salary would be equal to £88 8s. above, with an allowance for such transport as may be required when on duty.

Applications, stating age and place of birth, and giving details of education, training, and experience generally, and in Carbonising Machinery and Water-Gas Plant, and stating when free, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. C. C. LINDSAY AND PEIRCE, MM.Inst.C.E., 180, Hope Street, Glasgow, Agents to the Municipal Commissioners (from whom further information may be obtained), not later than Tuesday, 16th December, 1924. G 610

Waterworks Engineer.

WANTED, for large Waterworks in Scotland with large scheme in hand a TEMPORARY ASSISTANT, with good experience of pipelaying and concrete work and contractor's final measurements. Salary £330. Send chronological statement of experience, state of health, age and testimonials. —Address, G 524, Offices of ENGINEERING.

Required, Fully Qualified

ENGINEER-SALESMAN, age 30–35. Thorough practical and chemical experience of Petroleum Technology. Fluent French and German an advantage. Replies, which will be treated in confidence, must give age, details of experience, salary expected, etc.—Address, G 557, Offices of ENGINEERING.

An Engineer is Required for

a Tin Mine in the Federated Malay States to erect a complete Power Station including Brush-Ljungstrom Turbo-Alternators, water tube boilers, etc., and to subsequently take charge of the running of the plant and electrical machinery. Salary £700 per annum, with free quarters.—Address, with full particulars of experience, age, etc., G 612, Offices of ENGINEERING.

Assistant Engineer Re-

QUIRED by the GOVERNMENT of the GOLD COAST for service with the Kumasi Public Health Board for a tour of 12 to 18 months' service with possible extension. Salary £480 for the first three years of service, then £510 rising to £720 a year by annual increments of £30 and thence to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passage. Liberal leave on full salary. Candidates, age 25 to 35, preferably single, must be A.M.I.C.E., or A.M.I.Mun. & Cy.E., or hold equivalent professional qualifications. Must have had a good office training, preferably in a Municipal Engineer's office, be good Surveyors and have had experience in Drainage, Town Planning and other Municipal Works.—Apply at once stating age, qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/13236. G 598

Section Engineers (6)

REQUIRED for the CONSTRUCTION BRANCH of the FEDERATED MALAY STATES RAILWAYS, for four years' service with possible extension. Salary $400 a month rising to $475 a month by annual increments of $25 a month plus a temporary non-pensionable allowance of 10% which is liable to cancellation or revision, plus a commuted Field Allowance of $50 a month. The exchange value of the dollar, in sterling, is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage provided. On expiration of agreement a bonus of six months' salary may be allowed provided the work and conduct of the person engaged has been in every way satisfactory. Candidates, age 30 to 38 and unmarried, must be fully qualified Railway Engineers who have received good training and experience on recognised European, American or Colonial Railways. Members or Associate Members of the Institution of Civil Engineers preferred.—Apply at once by letter, stating age, whether married or single, and particulars of qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting at top of application M/13264. G 562

EDMONTON URBAN DISTRICT COUNCIL.

EXTENSION OF SEWAGE DISPOSAL WORKS.

APPOINTMENT OF FOREMAN.
The Council invite

Applications from Suitable

Candidates for the APPOINTMENT of TEMPORARY GENERAL FOREMAN for the Construction of the Sewage Disposal Works Extension, the estimated cost of which is £140,000.

Candidates must have had considerable experience as Foreman on large works, particularly concrete construction, and should preferably have had experience in dealing with "Unemployed" labour. The work is estimated to last 18 months and the salary offered is £7 7s. per week.

Applications, endorsed "Works Foreman," giving age, experience and references, are to be delivered at my Office not later than Twelve o'clock Noon on Saturday, December 13th, 1924.

CUTHBERT BROWN, M.B.E., M.Inst.C.E., Engineer and Surveyor.

Town Hall,
Edmonton,
London, N.9. G 573

METROPOLITAN WATER BOARD.

MECHANICAL ENGINEERING ASSISTANT.
The Metropolitan Water Board invite

Applications for the Appoint-

MENT of a MECHANICAL ENGINEERING ASSISTANT at a commencing salary of £280 per annum, plus bonus. Applicants, who should be between 28 and 40 years of age, must be Engineers having an extensive practical knowledge of the manufacture and operation of steam engines and boilers, and should possess a first-class Marine Engineer's Certificate from the Board of Trade. The Appointment will be held during the pleasure of the Board.

The salary above mentioned is based on pre-war conditions and is subject to a temporary fluctuating bonus which at the present time amounts to £118 7s. 11d. Subject to a satisfactory report by the Chief Engineer, the basic salary will be increased to £300 as from the 1st April, 1924.

Applications (which must be in the candidate's own handwriting), stating age, qualifications and experience, and accompanied by copies of not more than three testimonials, must be addressed to the undersigned, endorsed "Mechanical Engineering Assistant," and must reach the Offices of the Board not later than Twelve o'clock Noon on Thursday, the 18th December, 1924.

The selected candidate will be required to pass satisfactorily a medical examination by the Board's Chief Medical Officer, and to undertake in writing to join the Board's Superannuation and Provident Fund.

Canvassing is strictly prohibited and will disqualify.

G. F. STRINGER,
Clerk of the Board.

New River Head,
173, Rosebery Avenue,
Clerkenwell, E.C.1.
December, 1924. G 563

REPARATIONS AND THE BRITISH ENGINEERING INDUSTRY.

III.—CAN BRITISH INDUSTRIES BE SAFEGUARDED?

(From a Correspondent.)

IN two previous articles it has been contended that the putting into operation of the Dawes plan implies an intensification of German production for export, and that such intensification is likely to lead to more severe competition in engineering products than in those of most other British industries. It may be thought that the picture has been somewhat overdrawn. The plan is, and has been, in operation for some months, and as yet there have not been any ill-effects on a scale which would justify so gloomy a forecast. This view would seem to under-estimate the grave but temporary difficulties under which German manufacturers are labouring as a result of the general dislocation which is the aftermath of the Ruhr episode, and in particular of the stringency of credit conditions. In the heavy industries, for instance, the German handicap in the way of financing large contracts are still insuperable with a rate of interest of from 18 per cent. to 20 per cent. on borrowed money, as compared with 4½ per cent. in this country. For the time being, this is an effective shield to many branches of our industry, but it is a condition which cannot last. The enormous over-subscription of the international loan of 40,000,000*l.* recommended by the experts was in itself an indication of the belief of the world in Germany's ultimate advance to solvency. The Germans have not been slow to realise the value of this manifestation as propaganda, and already municipal and industrial loans on a large scale are being raised, particularly in the United States. It would be idle to speculate how long it will take for Germany to throw off her shackles in the matter of credit. It may be hazarded that twelve or eighteen months would be a safe upper limit, while it would not be surprising if she anticipated such dates by a considerable period. If this view is correct, the difficulties which were forecasted for British engineering in a previous article may be expected to materialise in the not distant future, and it may be worth while to consider what steps can be taken to meet them.

In the first place there can be no question of going back on the Dawes plan at this stage. The Allied and Associated Powers have adopted the plan largely through the mediation of British Governments, and this country is definitely committed to the plan by the signature of its representatives. There is little likelihood of world opinion changing, at least for some years, sufficiently to throw over the Report, and for this country to back out of the scheme alone would not solve her difficulties if it were practicable.

Within the limits of the scheme, it will not be of any use to us to demand that reparations be paid in kind, since whether Germany pays by sending goods direct to this country or by selling them elsewhere and remitting cash, her goods will come into competition with ours in the world's market if they are the products of an industry competitive to one of our exporting industries. Nor would it be any use, if it were possible, to define certain categories of non-competitive goods in which payment is to be made by Germany as long as she is selling competitive goods for other purposes, such as to pay for her own imports. It is clearly only a verbal distinction which particular set of goods is earmarked for reparations.

Tariffs cannot be employed by us to exclude German goods from other markets than our own. If they could they would, to the extent that they were successful, render it practically impossible for Germany to pay reparations. This last consideration would apply no less to a system of commercial treaties by which this country might attempt to obtain preference for British goods. With regard to our own market, even if tariffs were practical politics, they would to a great extent fail of their purpose. In the engineering industry as a whole, for example, the volume of German competition in our home market is negligible.

Nor can we hope that the "principle of commensurate taxation"—that is to say that Germany should be compelled to pay at least as heavy taxation as any of the Allied belligerents—will reduce the difficulties which we shall have to face. If the German costs of production increase owing to higher taxation, it will be incumbent upon German manufacturers to reduce their costs in some other direction if they are to maintain their export trade with a favourable balance. This aspect and the measures taken by the German Governments to assist German export industries have been dealt with in a previous article.

In short, it is apparent that there is no easy or obvious safeguard against the dangers ahead. At the same time, though it is not within the capacity of a British Government, still less of a single industry, to prevent Germany from carrying out her obligations, it is at least theoretically possible that British engineers, by their own efforts or with a measure of Government co-operation, might prevent reparations being paid at their expense. What is the probability in this matter?

If the belief of the experts as to Germany's ability to compete successfully with us and the rest of the world to the extent of 125,000,000*l.* a year surplus of exports is justified, what are the underlying factors which enable her to do so? It would seem that the principal factors are her great new equipment and organisation for production, her virtual absence of capital liabilities, her low wages and long working hours, and the policy of the German Government in subsidising her export industries at the expense of the rest of the community. Assuming that as a result of the Dawes plan the other principal advantage which Germany has enjoyed of late years, for instance, a depreciated exchange, will disappear, it would seem that it is only by an attempt to counter these factors that British industries can be safeguarded.

There can be no doubt that in the matter of national equipment the Germans have left us far behind in post-war years. The development of her lignite production and of electric power supply from the utilisation of her water resources, and even the wind, has more than replaced her losses of coal fuel under the Peace Treaty. The re-equipment of her railways and extensive railway electrification schemes have added to the efficiency and cheapness of her admirable transport system. We do not possess Germany's natural resources in all of these directions, but if a policy of courage and imagination on similar lines, notably in the matter of railway electrification, were to be pursued in this country, it would go a long way to neutralise Germany's existing advantage. It may also be argued that to give the British engineering industry a substantial volume of work in the home market at the critical period when German competition begins to be felt would be the most valuable form of help in meeting that competition. It is difficult to see that the proceeds of our share of reparation payments could be more effectively used than in financing schemes for increasing the efficiency of our transport system and power resources.

In the matter of the absence of capital liabilities in German industry through the depreciation of the mark, it may prove that the burden of the German Industrial Bonds Scheme will neutralise what would otherwise be a very considerable advantage. It is not easy to see any practical measures that could be adopted in this country to counter it.

The case is very different when we turn to the serious question of the wages of labour and hours of work in the industries of the two countries.

TABLE I.—*Nominal Average Weekly Wage in British and German Engineering Industries—June*, 1924.

	Great Britain.		Germany.	
	Rate in shillings per week.	Per centage of pre-war	Rate in gold marks per week.	Per centage of pre-war.
Skilled	56/2	148·7	34·91	83·5
Unskilled ..	40/3	184·5	25·88	91·7

Note.—The German rates are inclusive of family and social allowances.

It is a characteristic of German wages that through all the fluctuations to which they have been subject owing to the collapse of the mark they have remained disproportionately low as compared with other countries. But whereas the relationship has hitherto been difficult of estimation, the return of a stable currency makes some comparison possible. In the preceding table (No. I) the weekly rates of the various grades of engineering workpeople in the two countries are given for June, 1924, since when there has been no alteration.

Serious as is this discrepancy, it is aggravated still further when taken in conjunction with hours of work. The following table (No. II) shows the position in the German metal working industry as compared with our working week of 47 hours:

TABLE II.—*German Metal Industries—Hours of Work.*

District.	1913.	End 1923 hours.	Beginning 1924 hours.	Calculation of overtime in 1924 after: hours.
North West (from Dusseldorf to Dortmund) ..	54–60	48	57½–59	58
Berlin	54–60	48	54–60	61
Breslau	54–60	48	54–60	55
Stuttgart	54–56	46	54–60	55
Magdeburg	54–60	48	56	57
Mannheim	54–56	46	54–60	61

Roughly, the same relationship exists between the two countries for the wages in the primary and secondary industries which provide the raw materials of the engineering industry. When it is recalled that the total labour cost (including "wages on materials") comprises 80 per cent. of the cost of most engineering products, the importance of this factor will not be overlooked. It would appear that co-operation between the representatives of employers and employed in the threatened industries by watching developments in Germany and adjusting their internal affairs accordingly is essential if competition from this source is to be met. This should not be taken as advocating the immediate introduction of longer working hours and lower wages in this country. It is probable that German labour will be able to enforce some modification of their present status, and as long as a depression of the British standard of living can be avoided, it should, and no doubt will, be avoided. The contention simply is that the two parties in British industry should bear in mind the competitive position in these respects when making future adjustments, since there is here a reserve which might turn the scale in our favour even in extremities.

The last but by no means the least of the advantages which German export industries enjoy is the support of their Government. The German policy before and since the war has been the subsidising of export industries at the expense of the community as a whole. Among the numerous forms which such assistance may take perhaps the special railway freights for certain industries were the most important before the war. It seems likely that this will be replaced to some extent in the new conditions by preferential rates for electrical power supply, and no doubt later on by much needed credit facilities.

In this country the respective positions of sheltered and unsheltered industries in recent years have become too well known to need description, but at the present time it will hardly be denied that the sheltered industries are practically subsidised at the expense of the export industries—the exact opposite to the German method. It may well be that the competition arising from German reparation payments will compel us to face this question once for all, and to explore some conscious policy of adjustment by which the sheltered industries bear some share of the national struggle for reconstruction, instead of holding the community to ransom. It is notorious that among the unsheltered industries the industry which is suffering perhaps more than any others on this account is the engineering industry, being itself usually the final process of a long chain of primary and secondary processes. It is therefore affected more than most industries by the cumulative costs for transport, taxation and other internal charges. No doubt not the least effective safeguard that will be able to be devised will be to see that our own engineering industry is fostered and assisted no less than its German competitor. If this is done effectively there need be little fear that the

superiority of British workmanship and the engineering genius of this country will continue to tell in the future as in the past.

STRAUSS BASCULE BRIDGE OVER THE BANN RIVER, IRELAND.

By E. S. Needham, Assoc.Mem.A.S.C.E.

On the London Midland and Scottish Railway in Ireland the main line between Belfast and Londonderry crosses the Bann River at Coleraine. This line, until recently, was known as the Midland Railway, Northern Counties Committee, under which management the Coleraine Deviation was undertaken. Fig. 1 shows the location of this deviation with respect to the old alignment, which, since the opening of the new bridge to traffic, on March 21 last, has been abandoned; the old bridge has now been removed. The old bridge which dates back to 1860 was carried on timber pile supports, and the superstructure, including a swing span 100 ft. long, consisted of deck lattice wrought-iron girders. The renewal of the bridge was the principal object in view in deciding on the deviation. The Bann River, which at this point is about 4 miles from the sea, is navigable for coasting vessels as far as the "harbour" at Coleraine. From 350 to 400 boats per year arrive at and leave the quay, which is a short distance upstream from the old bridge. A movable span of the bascule type was adopted in the new bridge. This provides one opening of ample width for the navigation channel which is at an angle of somewhat less than 90 deg. to the new railway location.

The new bridge is illustrated in Figs. 2 to 24, Plates LXXVIII to LXXX, and page 759. Figs. 2 and 3 show the completed structure, the former taken from the Londonderry end, with the bascule raised, and the latter from the Coleraine shore, showing clearly the curve to which the girder spans on the Londonderry end are set out. This end is laid out on a curve of 1,320 ft. radius. The gradient across the bridge is 1 in 125, falling towards Londonderry. This gradient was required to give sufficient elevation at the road crossing between the Bann Bridge and Coleraine station. At this point a new 80-ft. girder span, known as Millburn Road Bridge, spans two roads at their junction. Between Millburn Road and Bann Bridge, a heavy fill was required and the embankment at both ends of the bridge was extended as far as practicable, with respect to the tidal shores of the river and the soft meadow bottom at the Coleraine end. Both abutments are of the buried type, supported on concrete piles. Concrete piles were adopted for supporting the river piers, owing to the nature of the river bottom, which varied greatly in the stratification overlying the very hard clay into which the piles were driven. At the lowest point in the bed of the river, the alluvial deposit or "sleech" averaged 4 ft. in depth, then clay with gravel giving uniform driving, then very hard driving indicating compact gravel, then uniform driving indicating clay, finishing up in very hard compact boulder clay.

The illustrations on Plate LXXIX give various drawings of the work to several of which reference will be made in greater detail below. A general elevation and plan are shown in Figs. 4 and 5. Figs. 6 and 7 are respectively an elevation and plan of the bascule span. Fig. 8 is a cross-section of the bridge at the operator's cabin, a side elevation of this being given in Fig. 9. A cross-section of the bascule span is given in Fig. 10. Fig. 11 represents a typical section of the fixed main girders and gives details of the cylinders, diaphragm bracing and piling, details of the piles themselves being shown in Figs. 14 and 15. Figs. 16 to 18 refer to the bascule operating machinery.

The length of the bridge between abutments is 800 ft. The navigation channel is 70 ft. in the clear between fender lines, as shown in Figs. 4 to 7. The adjacent piers are 85 ft. apart, centre to centre, while including the small approach span of 20 ft. the total length of the bascule portion is 105 ft. With the location of the opening span given, the most suitable arrangement for the fixed spans resulted with piers at 77 ft. centres, the girders being 75 ft. long centre to centre of bearings.

All piers and the two abutments are supported on concrete piles, 14 in. by 14 in. in section (Figs. 14 and 15), of 25-ft. and 30-ft. lengths, driven with a 40-ft. pile frame travelling on a temporary stage. A 45-cwt. hammer was used, average drop 3 ft., and average number of blows per pile, 5,400. The penetration averaged 16 ft. through layers of boulder clay and gravel, the total of gravel being approximately 4 ft. These piles were calculated to carry an average total load of 37 tons per pile.

The typical pier consists of two cylinder bases, 8 ft. in diameter, each cylinder capping 7 piles (see Figs. 11 to 13). Above the base the shaft is 5 ft. in diameter, with some steel reinforcement. The two shafts are joined by a diaphragm, also reinforced.

This is seen in Fig. 11, and the cross-section to the right of this figure. The bases were carried down to gravel, inside a casing of steel cylinder plates, bolted in sections. The amount of wet excavation and pumping in the shore piers was small, as advantage was taken of the spring tides, the range of the tide in the Bann River at Coleraine having a maximum of about 8 ft. At Pier VIII. the penetration of the steel cylinder was very little, hard gravel bottom being found at 8 ft. below low water. Some concrete was placed with

Fig. 1. PLAN SHOWING RAILWAY DEVIATION.

a tremie to seal the bottom. At Pier V the penetration was about 6 ft. into a clay-gravel stratum which permitted the cylinders to be pumped dry for excavating and concreting.

Piers VI and VII were built inside a cofferdam, in order to ensure that the bases of the bascule pier were founded on hard material for support in addition to the concrete piles, of which 20 were driven in pier VI. Further, the 9 ft. diameter cylinders of this pier are connected with a diaphragm the full depth, with a considerable quantity of reinforcing steel, so that the expense of constructing this pier in the dry was justified, although the use of the cofferdam was not contemplated in the pier design.

The cofferdam measured 41 ft. by 35 ft., constructed of four settings of heavy timber and tie rods, and sheeted with 14 in. Lackawanna arched web steel piles, 40 ft. long, with an average penetration of 16 ft. The steel piling was driven with a 45 cwt. hammer into the stratum of boulder clay.

No appreciable damage was done to the heads of the piles in driving, but the bottom ends were badly split and twisted. The extracting of the steel piling was more costly than the driving. Ransome 10 cwt. and McKierman-Terry No. 9 extractors were used, suspended from the jib of the derrick-car used for steel erection.

The bridge carries a single line of railway, 5 ft. 3 in. gauge. The live loading adopted for design is that given by the Railway Engineers Association (1920) equivalent uniformly distributed live load for railway equipment with a range of axle loads of approximately 18 to 22 tons. The live load impact $\frac{120}{L + 90}$ and unit stresses used are in accordance with the latest British standard specification.

The nine girder spans in the bridge are all alike, 75 ft. long, centre to centre of bearings. Fig. 11 shows the cross section of these spans and the typical pier. The deck arrangement is an adaptation of a concrete slab to the steel stringers and cross girders of the ordinary open-floor design. The design of the slab, in addition to carrying the permanent way and ballast, embodies the encasing of the stringers and the webs of the cross girders to within a foot of the main girders. The object of the encasing is to reduce maintenance, leaving the exposed steelwork readily accessible for painting, which explains the 1 ft. space between the edge of the slab and the main girder web.

The main reinforcement of the slab is transverse. Longitudinally, the concrete deck is divided by the cross girders into independent bays 12 ft. 6 in. long. About 40 cub. yards of concrete were placed for each span of six bays. A very rich concrete was required to meet the strength specifications of the Ministry of Transport, the mix finally adopted being 1 cement, 1½ sand, and 2½ basalt screenings.

The steelwork of the nine girder spans amounted to 400 tons. Each main girder (one side) weighed 14 tons. These girders were shipped in two lengths and the splices riveted as each pair of girders was assembled for erection. Two assembly stagings were built, one at each end of the bridge, from which each 14-ton girder was handled into place by a derrick-car constructed for the purpose. The body of the derrick-car, Fig. 19, Plate LXXX, consisted of heavy logs mounted on two bogies of 5 ft. 3 in. standard gauge, 40 ft. centre to centre. At the forward bogie, a steel A frame was used as the mast, mounted on a cross girder provided with extension pieces or out-riggers. The jib was of timber, 50 ft. long with a reach of 43 ft. 6 in. from the A frame to the middle of the 75 ft. girder in the slings. To balance the load, counterweight was added behind the boiler and winch over the rear bogie. The back stays and forward jib ties were flat bars. As the car travelled forward the outriggers cleared the tops of the girders already in place and were blocked up at the end of the last span erected. This was required to prevent the derrick from overturning when the girder was swung from the centre line of the bridge to either side before being lowered into its place. Figs. 20 to 22, Plate LXXX, show the derrick-car engaged on various operations. The first and last of these show girders being placed in position, in the former instance actually in a heavy wind. Fig. 21 shows the car being used for the erection of the bascule trunnion posts.

Both main girders and half the floor steel of one span could be placed in less than one day. Riveting the stringer and cross girder connections followed, after which a temporary road was laid for the derrick-car and the balance of the floor completed. One week was the average time required to complete each span, fully riveted, including the assembly and field splices of the main girders.

In erecting the bascule span, heavier loads were handled in a similar manner. The method of erection for the bascule, noted later, required no alteration in the derrick-car, but owing to its limitations, the nose-end pieces of the bascule girders were handled into place with a 3-ton hand derrick mounted at Pier V, and their splices made over the water.

The opening span, Figs. 6 to 10, Plate LXXIX, is a Strauss trunnion bascule with underhung counterweight, and is probably the first example of this type in the United Kingdom. The railway company desired the counterweight to be underhung to give a more pleasing effect. The height of the bridge above water was sufficient to permit this arrangement, although as described later, heavy aggregate had to be used in the counterweight to give the necessary weight within the limited dimensions. The 20-ft. approach span (between Piers VI and VII) is not an essential in a bascule of this type, but was adopted by the railway company for various reasons. The principal advantage in this case lies in the extra rigidity of the foundations, especially for resisting longitudinal forces. Having two piers close together the four cylinders are connected with substantial diaphragms of reinforced concrete. These are shown in Figs. 6, 8 and 9. The longitudinal diaphragms give a large margin of stability to Pier VI, the main support of the bascule. Another advantage is in providing substantial support to the machinery and operator's house, which is carried on concrete cantilevers embodied in the design of both piers, as shown in Figs. 8 and 9.

Without the 20-ft. span the effect of the break in the continuity of the bridge caused by the operator's house and counterweight would not have been pleasing. A decided advantage results in the alignment of the main girders of the bascule span with the girders of the fixed spans, for, if Pier VI were also the support of the adjacent 75-ft. girder span, the main girders of the bascule would have had to be spread further apart, thus breaking the continuity of the line of girders.

The structural supports on Pier VI consist of four trunnion posts, in pairs corresponding to the arrangement of the four main bearings of the two main trunnions, each bascule girder being supported centrally on its trunnion between two bearings. Transverse and longitudinal wind bracing, machinery brackets, &c., make up the design of the stationary portion, and the whole is stiffened by the rail girders over the 20-ft. span.

The moving span is designed with the same arrangement of main girders, cross girders and stringers as that for the fixed spans. The fixed spans, having a concrete deck, required no lateral bracing, but for the moving span which has an open timber deck the usual system of bottom laterals and stringer bracing was necessary, as shown in Fig. 7. The timber floor consists of sleepers bolted to the stringers and planked over for footways (see Figs. 7 and 10). This planking adds weight and increases the area exposed to the wind, and was therefore put on as sparingly as possible. The weight of timber floor, rails and timber guard rails amounts to 285 lb. per lineal foot, which, in terms of counterweight required, amounts to nearly 20 per cent. of the total.

The main bascule girders are 8 in. deeper than the fixed span girders, the increase being required to accommodate the position of the main and counterweight trunnions for the required angle of opening. The girders act as a simple span for live load only, and therefore are subject to both positive and negative bending. The span length from main trunnion to front end bearing is 84 ft. The counterweight is suspended at a point 12 ft. to the rear of the main trunnion. The moving leaf may be considered as a cantilever beam of two unequal arms supported at the centre of gravity of the applied loads. The applied load of the span and flooring is at a point about 36 ft. forward from the main trunnion, which is determined by finding the centre of gravity of all moving loads except the counterweight. The applied load of the counterweight is taken at its trunnion, from which it is suspended as noted above at a point 12 ft. back of the main trunnion. The amount of counterweight required is therefore in the ratio of 3 to 1, based on these lever arms and the resulting horizontal moments. The location of the counterweight trunnion (see Figs. 6 and 17), which is 9 in. above the level of the main trunnion, is proportioned to the distance of the centre of gravity of the moving span below the level of the main trunnion. In this case the possible angular opening of the bascule is 82 deg. The counterweight (Fig. 6) maintains the horizontal plane during motion, and is guided by two small links, the connecting pins of which are located at points which make a parallelogram with reference to the main and counterweight trunnions. The total moving weight is about 275 tons, of which about 205 tons are in the counterweight.

The counterweight is of reinforced concrete, cast around a transverse steel frame. This frame transfers the load of 205 tons to the counterweight trunnions by means of short hangers which engage the counterweight pin (see Figs. 6 and 16). The bottom and sides of the counterweight are of ordinary concrete reinforced with expanded steel mesh and poured to a thickness of 3 in. during the concreting of the whole mass, which consists mainly of steel punching concrete. The desired weight of the latter was 256 lb. per cubic foot and preliminary test cubes giving this weight were proportioned as stated in the Table on this page.

Contrary to usual practice, the counterweight was built before placing the bascule girders. If this had not been done, the bascule would have had to be erected in the open position in order to maintain navigation. This method of erection was decided against in favour of building the counterweight in advance in the closed position with the risk of making the counterweight connection to the main girders, without mishap, when the girders were erected across the navigable waterway. Permission was obtained to close the channel during five days, in which time the girders were erected, including one field splice in each, and all riveting of the floor steel completed. No difficulty arose in driving the counterweight pin as the counterweight had been accurately located and the precaution was taken to add a pilot and driving nut to assist in entering the pin.

—	Gross Volume.	Net Volume.	Weight.
	Cub. Ft.	Cub. Ft.	Lbs.
Steel Punchings ..	0·606	0·327	160
Screenings 0·290	0·995	0·673	96
Sand 0·470			
Cement 0·235			
		1·000	256

FIG. 24. RAIL-JOINT AT END OF BASCULE SPAN.

Building the counterweight in the closed position gave ample space underneath it for substantial falsework, which would have been required in either case to support the wet concrete, there being no steel box in the counterweight design. The falsework consisted of bents of 12 in. by 12 in. timbers resting on the pierwork, decked over and floored. Timber casing was used to form the sides, which were awkward to get at in the limited clearances. A steel box would have facilitated the work at probably no greater cost.

Special oil grooves are provided for the main steel trunnions in contact with the phosphor-bronze bushings, and are designed to facilitate cleaning out at intervals. Stauffer lubricators are used throughout. The phosphor-bronze used in the bearings is an alloy selected for withstanding high pressure at slow speed. The chemical composition is as follows:—Copper, 83·57; tin, 15·17; lead, 0·27; phosphorus, 0·99. A 1-in. cube of this alloy in the compression test showed elastic properties up to 10 tons load. At 45 tons load the permanent set was 0·088 in. and the specimen showed no signs of cracking. The average working load in motion is less than 1 ton per square inch.

Details of the machinery are shown in Figs. 16 to 18. The main operating pinions engage the cast steel racks which are housed in structural steel segments attached to the main girders. The rack and pinion teeth are designed to withstand a wind pressure of 15 lbs. per square foot normal to the whole area of the open span. The resulting tooth pressure is 60,000 lb. at each rack. Gear reduction between motor and main pinion is effected in three stages. The middle stage includes an equaliser gear, located on the centre line of the bridge, the shaft being cut at this point to equalise the tooth pressure at the two racks. All gears are of cast or forged steel and all teeth machine cut.

The power unit consists of a petrol engine and hydraulic transmission. The engine is a 25-h.p., three-cylinder Pelapone engine, direct connected to the hydraulic pump and running at 800 r.p.m. The hydraulic transmission is on the Hele-Shaw system, with a No. 9 pump and M.40 motor, the latter driving the gears at 180 r.p.m. This drive gives a very flexible control, speed regulating and reversing being done through the levers controlling the floating ring in the pump. This valve action functions automatically by means of a spring control, which allows the floating ring to go into the neutral position on overload without stalling the engine. Should the operator fail to shut off power when the bridge is approaching the buffer stops in opening or closing, the automatic feature of the pump control prevents any damage to the equipment. Two minutes is required fully to open or close the bridge in ordinary weather, and at slower speed there is ample power to operate the bridge in the stormiest weather. Auxiliary hand gears are installed in the engine room for emergency use.

The engine is equipped with a self-starter, taking current from two 12-volt Tudor batteries in parallel. The electrical installation also includes a 30-volt Ediswan accumulator for lighting purposes, and an Armstrong Whitworth lighting set for charging the batteries.

The operator's house is a two-storey steel-frame building, with concrete floors and roof. It is shown in outside elevations in Figs. 8 and 9 and in plan and sections in Figs. 16 to 18. The walls are 2 in. thick, plastered on Hy-rib fastened outside the steelwork. The inside is sheeted with Poilite. Ample window space is provided, especially in the upper storey or operator's control room. The lower storey is the engine room or machinery house. The equipment in the operator's room includes telephone, switchboard, machinery control and brake levers and lever for operating the locking bolts. In place of the usual stove, a "Sentry" heater is installed and connected to piping from the circulating tank to the engine to prevent the water from freezing in cold weather. An indicator pointer on the wall shows the operator the position of the bridge.

The locking bolts, of which there are two, as shown in Figs. 16 and 17, engaging the bedplate guide castings at the far end of the bridge, are operated from a cross shaft controlled by the lever in the operator's house. They are provided, as a measure of safety to retain the bridge in its closed position, and are also interlocked with the tablet instruments controlling admission of trains to the section of line in which the bridge is situated. In closing the bridge an air buffer at the far end comes into play to cushion the final closing as the girders lower on to their seats between the guide castings. The rail joint castings are shown in the photograph reproduced in Fig. 24, annexed, and are alike for both ends of the bascule span.

The timber fenders consist of 12 in. by 12 in. piling in double rows, braced with 12 in. by 12 in. booms and 6 in. by 12 in. struts and diagonals. The walings are 6 in. by 12 in., and protected at the corners abreast of the channel with 6 in. by ¾ in. straps; 3,500 cub. ft. of pitch pine timber were used and about 4 tons of bolts, washers, tie rods, drift bolts and straps.

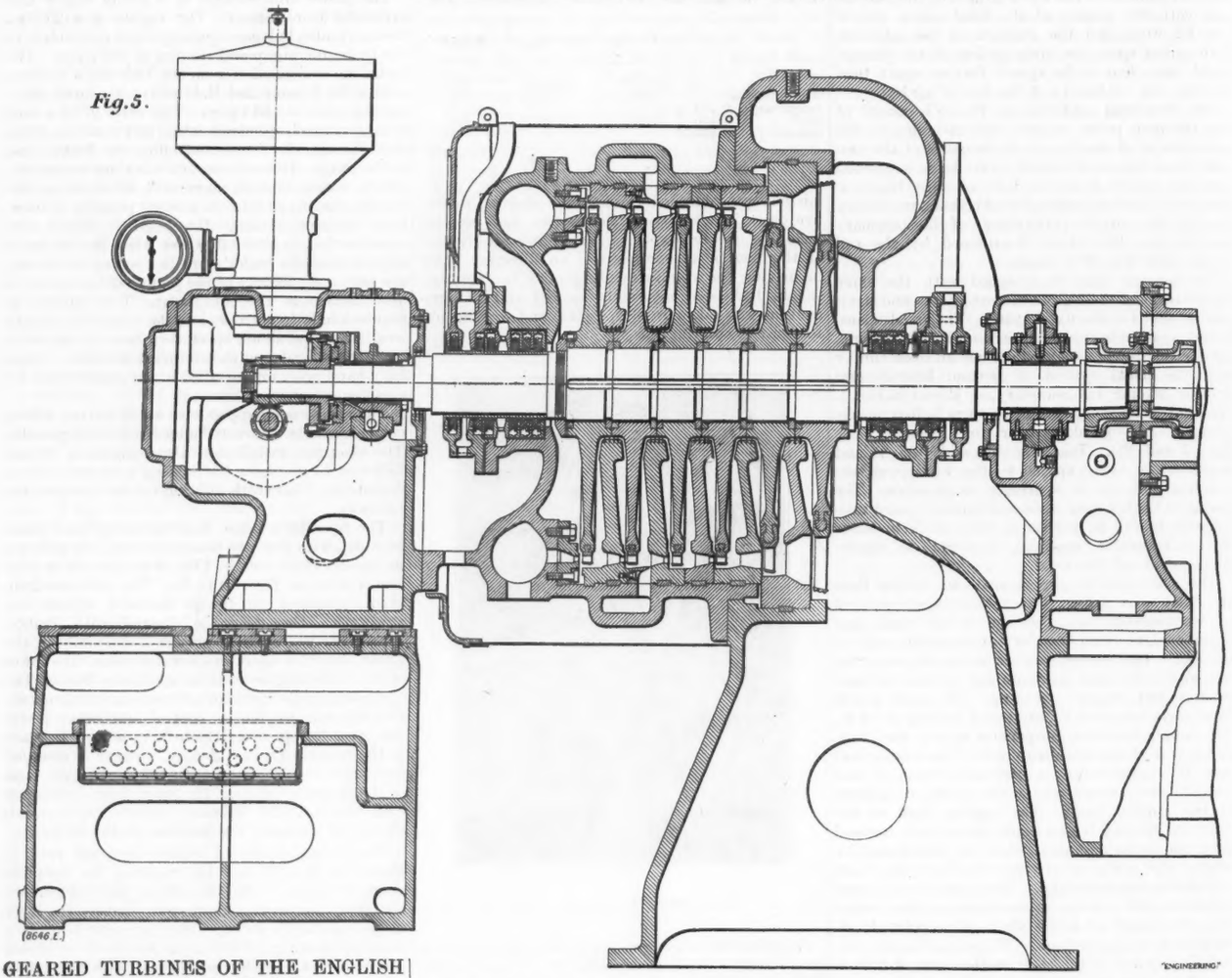
The work was carried out under the direction of Mr. B. Malcolm, Chief Engineer, Midland Railway, N.C.C. resigned, and Mr. W. K. Wallace, Chief Engineer, L.M.S. Railway, N.C.C., with Mr. R. B. Lindsay, resident engineer for the railway. For the contractors, Sir W. G. Armstrong, Whitworth and Co., Limited, Civil Engineering Contracting Department, Mr. T. F. Young was chief agent; Mr. T. S. Anderson was in charge of construction at the site; the writer being engaged on special features of the design.

The steelwork of the nine girder spans was supplied by Messrs. Dorman, Long and Co., Limited the bascule steelwork from the works of Messrs. Armstrongs and Main, and the machinery from the Elswick works of Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited.

SECTION OF 1,000-KW. GEARED TURBINE.

CONSTRUCTED BY THE ENGLISH ELECTRIC COMPANY, LIMITED, ENGINEERS, RUGBY.

Fig. 5.



GEARED TURBINES OF THE ENGLISH ELECTRIC COMPANY.

(*Concluded from page* 699.)

As will be seen from the sectional drawing, Fig. 5, above, the turbine comprises six stages, all of which are of the single impulse type. The way the wheels are mounted on the shaft is particularly worthy of notice. Details of the arrangement are shown in Figs. 13 and 14, page 762. Each wheel rides on a pair of split rings, like piston rings, one of which is illustrated in Fig. 14. To assemble the wheels one of these rings is first slipped over the shaft and put into its position against the solid collar which locates the wheels at the low-pressure end. The wheel being bored out to a slightly larger diameter than the shaft, can be easily threaded on, and its counterbore is then forced over the split ring. Another ring is then forced into the counterbore on the other side, so that the wheel is held free from the shaft by the rings only. The two feathers on opposite sides of the shaft prevent rotation both of the wheels and the rings, but produce no radial pressure on the interior of the wheels, which are held concentrically with the shaft by the uniform pressure of the rings on the overhanging portions of the boss.

One wheel having been fixed, another ring of slightly smaller internal diameter is sprung over the shaft and located in a groove which prevents endwise motion. The next wheel is then threaded on, and its counterbore forced over the ring. A ring is then forced into the opposite counterbore, as before, and this wheel is thus fixed. By a continuation of the process the whole series of wheels is assembled and the last one is held by a nut on the shaft. A large number of turbines in which this method of wheel forcing is employed have been put into service, and in no case has there been any trouble due to loosening of the wheels and their shifting along the shaft under centrifugal and temperature stresses. The longitudinal motion of each wheel is indeed strictly limited by the engagement of the alternate supporting rings with the shaft, so that there is no possibility of the wheels bunching together under any conditions. The wheels can be removed without difficulty, should this be required, by first pulling out, or destroying the rings in front, after which the wheel can be "worked" off the rear ring with no trouble.

The way in which the diaphragms are held in the casing is another feature worthy of notice, the same practice being followed as in the larger machines built by the English Electric Company. The diaphragms are in halves, split across the horizontal diameter, the joint being made by a brass key which avoids difficulty in opening the turbine after it has been undisturbed for a long time. The halves do not fit tightly into the corresponding parts of the casing, but each is secured by three feathers, two as nearly as possible on the centre-line of the machine and the other midway between. The side feathers rest in open-sided slots in the casing, so that they can be got into position, the lower and upper ones being held in feather-ways milled out in the usual way. The consequence of this arrangement is that the diaphragms are as free as possible from the casing, and their concentricity with the shaft is not affected by strains in the casing due to temperature.

Steam is admitted both to the upper and lower parts of the casing, but the two steam chests are quite separate, so that there is no possibility of high-pressure steam leaking at the horizontal joint of the casing, and the joint moreover is free from the bursting strain which would occur were the steam chests continuous one with the other. The casing is of cast steel, this material being carried solidly far enough along the body of the machine to embrace all the internal parts except the last diaphragm and wheel. Thus, no steam at high pressure or temperature comes anywhere near any part of the casing which is composed of cast iron, and the troubles due to growth and distortion of the iron are therefore eliminated. Cast in the steel casing is an overload-belt, which like the main steam chest, is separate in each half of the casing. This belt admits high-pressure steam to the nozzles of the third wheel, a guide ring fixed to the preceding diaphragm directing the steam as efficiently as possible to the entrance of the nozzles. The nozzle-area at this stage of the machine is sufficient to pass the required amount of high-pressure steam to develop an overload of 25 per cent. above the power developed under normal conditions, and this can be carried indefinitely, although necessarily at a certain sacrifice of efficiency.

Both the high-pressure and low-pressure glands are composed of carbon rings in three segments held to the shaft by garter-springs and air leakage is prevented by a steam-seal in the usual way.

GOVERNING MECHANISM FOR 1,000-KW. GEARED TURBINE.

CONSTRUCTED BY THE ENGLISH ELECTRIC COMPANY, LIMITED, ENGINEERS, RUGBY.

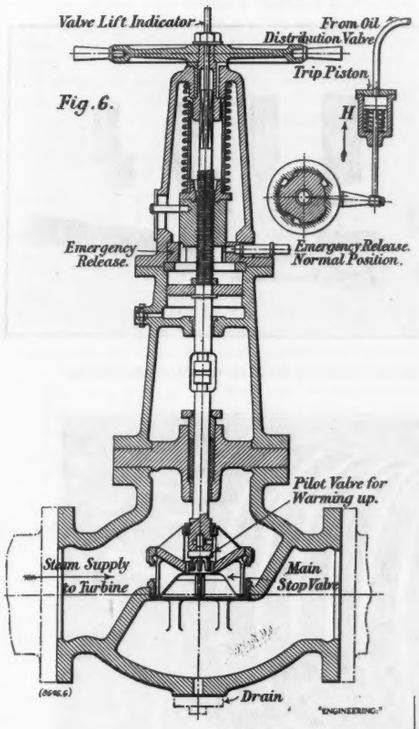


Fig. 6.

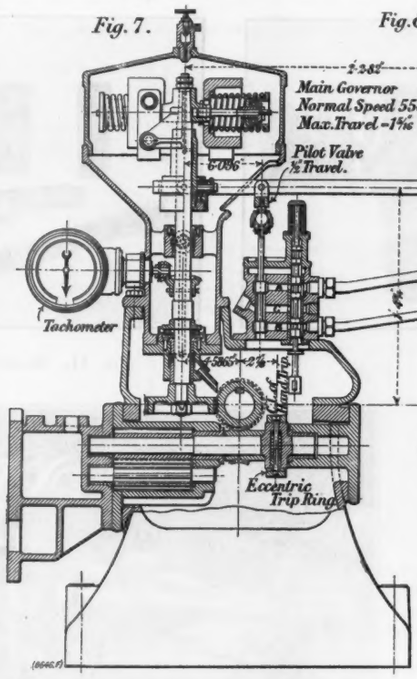


Fig. 7.

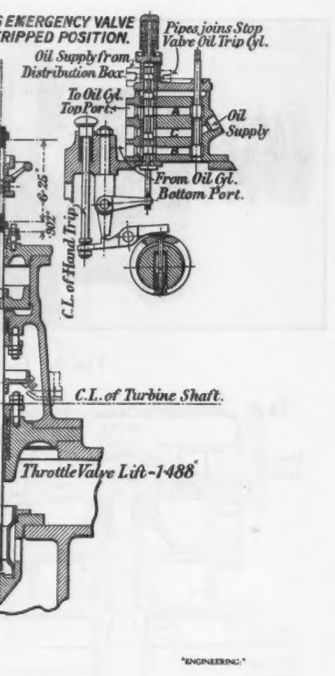

Pipes joins Stop Valve Oil Trip Cyl.
Oil Supply from Distribution Box
To Oil Cyl. Top Port.
Oil Supply
From Oil Cyl. Bottom Port.
C.L. of Hand Trip
C.L. of Turbine Shaft.
Throttle Valve Lift -1488"

Fig. 8. SEC. SHOWING EMERGENCY VALVE IN TRIPPED POSITION.

The shaft, where it passes through the high-pressure gland, is covered with a renewable tightly-fitting hardened steel sleeve, secured by grub-screws and ground in position. The high-pressure turbine bearing is of a very simple type, the keeps being enlarged and bored out on the outboard side to receive a Michell thrust bearing. Beyond this again is the steel worm-sleeve which drives the governor gear and pump. A nut secures both the sleeve and the thrust-plate against a shoulder on the shaft. The low-pressure bearing is of the self-aligning type, and is provided with shims for vertical and lateral adjustment. The pedestals carrying the bearings are bolted to the respective ends of the turbine casing and form the only supports of the machine, as no appreciable load can be taken by the exhaust connection. The low-pressure pedestal is firmly bolted down, but that at the high-pressure end is free to slide in longitudinal guides to relieve any stress which would otherwise be caused by the expansion and contraction of the turbine. The shaft being held by the thrust-block in the high-pressure pedestal retains its relative axial position in the casing, so that axial clearances remain constant.

The governor, with its relay valve, the oil pump, emergency governor and tachometer, are all accommodated on or in the high-pressure pedestal, the arrangement of these parts being as shown in Figs. 5 and 7, above and on page 760. The worm on the turbine shaft drives a horizontal cross shaft by means of a worm-wheel beneath it, and the vertical governor spindle by means of a worm at the side. Although the parts mentioned are all arranged with such great compactness, the readiness with which they may be inspected in position or individually withdrawn should be particularly noticed. Reference to Fig. 5 will show a large end-door giving free access to the interior of the pedestal. By undoing a few external bolts the governor, complete with its tachometer, can be lifted away, and the relay valve chest can be removed in an equally simple manner. The oil pump complete with its spindle and the emergency governor can be withdrawn from one side, and the whole of the pedestal mechanism therefore extracted for adjustment or examination with the minimum of trouble.

The appearance of the governor without its casing is shown in Fig. 9, and from this and Fig. 7 a good idea of its construction will be obtained. The weights are controlled by compression springs with external adjustment and ball-bearings are used in all joints. The latter feature makes the governor extremely sensitive to small variations in speed, and thus conduces to very close governing. By undoing the double nuts at the top of the spindle, the whole of the working parts of the governor, together with the sleeve, can be removed, without interfering with the spindle in any way. This is a special feature of the design, and the construction by which it is secured will be clear from the illustrations. The weight of the governor and spindle is carried by the thrust collar immediately above the lower bearing. This runs on thrust pads submerged in an oil-bath so that abundant lubrication is ensured.

The relay system by means of which the throttle valve is operated will be understood from Fig. 7. Oil under pressure is admitted to the space between the ends of a small piston valve which is under the direct control of the governor. The valve is shown in its normal mid-position in the illustration, under which conditions the throttle valve would not be closed as shown, but would be open by a sufficient amount to pass the required quantity of steam. Should the turbine speed fall the governor sleeve will be lowered, allowing the piston valve to drop and uncover the ports A and B. Pressure oil will then pass through the lower port B to the underside of the oil piston on the throttle valve spindle, thus causing the spindle to rise and open the valve a little more. The simultaneous opening of the upper port A by the piston valve allows the oil on the upper side of the oil piston to escape and pass away into the pedestal casing for lubrication purposes, and eventually back to the oil pump. Should the turbine speed rise, the converse operations are carried out, oil being admitted to the upper side of the oil piston and exhausted from the lower side, so that the throttle valve is forced downwards. The power actuating the throttle valve is very great, due to the oil pressure acting over the comparatively large area of the oil piston, but the work required of the governor is almost negligible, being confined to moving a small and perfectly balanced piston valve. Hence there is no force resisting the motion of the governor, and the least alteration in the position of the latter will bring about a continuous motion of the throttle valve until equilibrium is once more established. Hand adjustment of speed is provided by raising or lowering the small handwheel which forms the fulcrum of the governor lever on the throttle valve spindle. On the latter spindle, below the oil cylinder, will be noticed a small cup. The purpose of this is to catch any oil leaking past the gland above, so that the oil neither finds its way into the steam chest below, nor runs about and makes a mess on the turbine. The oil trapped by the cup is led away by the drain indicated and passes back to the reservoir. This detail is typical of the attention given to minor operating points throughout the design.

The emergency governor consists of an eccentrically-bored ring surrounding the cross-shaft which drives the oil pump. At normal and lower speeds this ring is held with its thick side in contact with the shaft by means of a small helical spring inserted radially within the shaft. Under these conditions the external surface of the ring runs concentrically with the shaft. Should the speed, however, exceed a predetermined amount the centrifugal force of the thicker side of the ring overcomes the pressure of the spring, and the ring takes up an eccentric position and strikes a latch immediately above it as shown in Fig. 8. The movement of the latch releases a bellcrank lever, and allows a piston valve to travel upwards under the action of a helical spring above. The arrangement will be quite clear from the illustrations. When this valve is in its normal position as in Fig. 7 the oil operating the throttle valve passes around it without hindrance. When the valve is in its tripped, or upper, position the ports A and B are shut off, but pressure oil can pass through the port C, and round the centre of the valve, to the top of the piston of the throttle valve, the lower side of the piston being at the same time open to exhaust. The throttle valve is thus positively closed.

The main stop valve, illustrated in Fig. 6, above, is closed simultaneously with the throttle valve when the emergency governor comes into action. The nut, in which the valve-spindle works,

DETAILS OF 1,000-KW. GEARED TURBINE.

CONSTRUCTED BY THE ENGLISH ELECTRIC COMPANY, LIMITED, ENGINEERS, RUGBY.

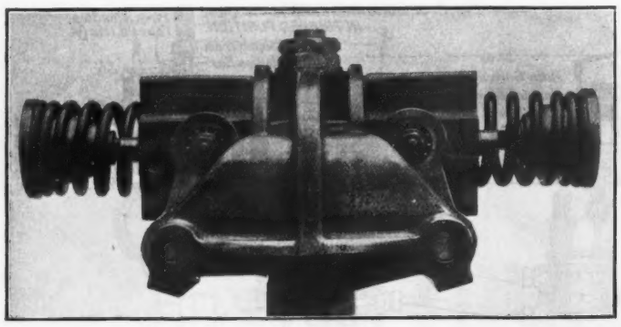


Fig. 9. Governor.

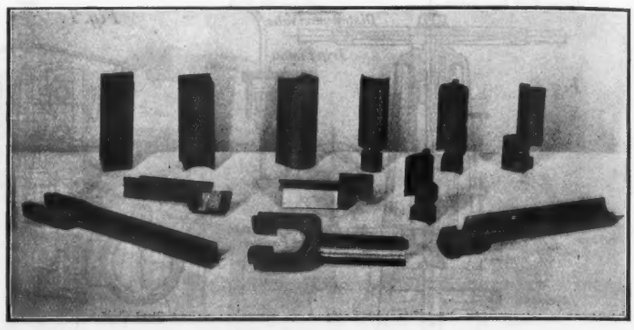
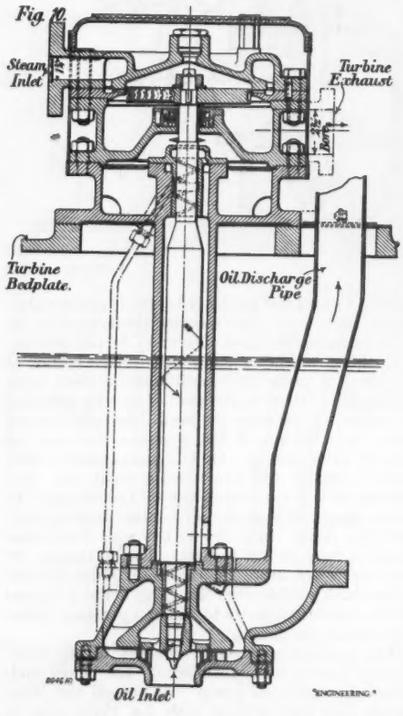


Fig. 11. Blading in Various Stages of Manufacture.



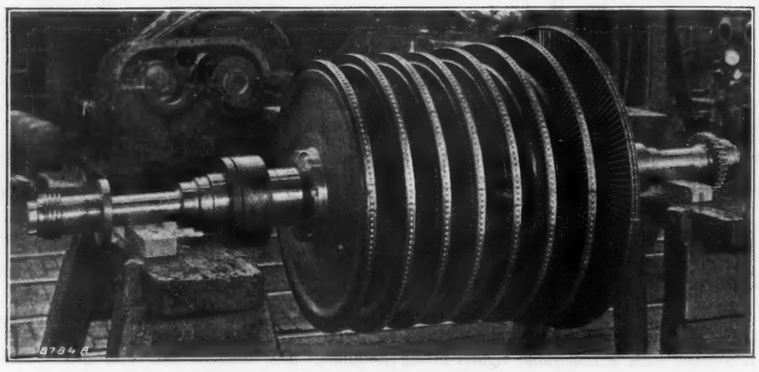
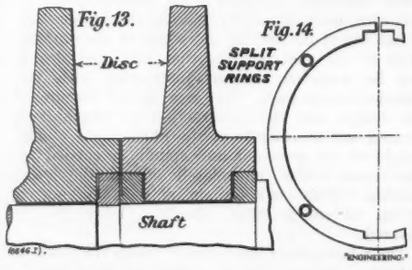


Fig. 12. Rotor for Eight-Stage Turbine.



is pressed downwards on to a seating by a powerful helical spring contained in the spindle casing. The nut is splined and the seating is provided with internal splines on which the nut-splines rest. A slight rotation of the seating by means of a lever projecting through the casing removes the support from the nut, which is thus driven downwards through the seating by the helical spring and the valve instantaneously closed. An air-dashpot prevents injury to the steam valve or its seating by mitigating the shock of closing. The method by which the emergency releasing ring is operated is shown diagrammatically in Fig. 6. It will be seen that the rotation of the ring is caused by the action of a spring beneath a piston in an oil cylinder. Any failure of the oil-pressure above the piston allows the spring to act and close the stop valve. The release of the oil pressure is effected by the upper end of the emergency pilot valve which, when tripped, opens the cylinder to exhaust. It may be mentioned that the main stop valve is of course closed by the failure of the oil pressure from any cause whatever so that the turbine is automatically shut down in case of any mishap to the lubrication system. This is a very necessary safeguard. Reference to Fig. 6, will show that the main steam stop valve is fitted with a small centre valve which is opened by the screw before the main valve is moved. This allows a small amount of steam to be passed for warming up the machine, and it also has the effect of causing the main valve to be partially balanced before it is opened, so that it has not to be lifted against the full pressure of the steam on its upper surface. The wheel handle by means of which the stop valve is operated does not rise and fall, but the amount of valve opening is definitely shown by an indicatory stem projecting from the spindle through the wheel-centre. A further convenience is an indicator on the side, which tells at a glance when the emergency device has tripped. After tripping, this device can be reset by rotating the hand-wheel until the nut has been raised sufficiently for the releasing ring to be turned back into position.

The main oil pump is of the geared type and is housed in the pedestal as shown in Fig. 7. It delivers oil at a pressure of about 40 lbs. per square inch for the operation of the governor relay gear already described, and the pressure is lowered to about 15 lbs. per square inch by a reducing valve, for lubrication purposes. The main oil reservoir is in the turbine bedplate, but an auxiliary tank may be placed in any convenient position should the quantity of oil required by the reduction gearing between the turbine and the generator make a larger storage capacity necessary. The oil pump is designed of such a size that it should furnish all the oil required both by the turbine and by the reduction gearing. Should the requirements of the gearing be sufficient to overtax the pump, a separate worm-driven pump is fitted to the gear-case.

It is, of course, desirable, and often essential, that the bearings of a turbine should be flooded with oil before the machine is started, and therefore before the normal forced lubrication is available. To meet this condition it is the practice of the English Electric Company to provide a small auxiliary oil pump which can be started before the main machine. It is, of course, stopped when the main pump comes into action, though it may be usefully brought into service should the oil pressure at any time fall below the normal. This can be arranged to be done automatically if desired. The type of auxiliary oil pump usually supplied with turbines of the kind we are describing is illustrated in Fig. 10. As will be seen, a single inlet overhung centrifugal impeller is mounted at the lower end of a vertical spindle, at the upper end of which is a little impulse turbine of the simplest possible description. The turbine wheel is a steel disc about 5 in. diameter with buckets milled from the solid. The turbine casing is bolted to the bedplate and the pump beneath it is deeply submerged in the oil tank. The whole arrangement can be readily withdrawn for examination by the removal of a few nuts. The oil-cooler is quite independent of the turbine bedplate, and is usually placed in some convenient position in the engine-room basement or arranged near the steam end of the turbine. The cooler is somewhat similar in design to an ordinary surface condenser. The cooling water passes through straight brass tubes and the oil flows over their outer surfaces in a zig-zag path, directed by means of baffle plates.

The blading of the turbine wheels is made of 3 to 5 per cent. nickel steel, each blade being

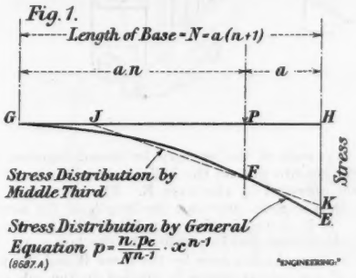
machined separately from the solid bar. A group of blades, showing various stages of manufacture, is illustrated in Fig. 11, and Fig. 12 shows an eight stage rotor with bladed wheels. To obtain the correct spacing of the blades each has a thickened root, which not only forms a distance piece, but, being solid with the blade, it also reduces the intensity of the root stresses, which would otherwise occur. For the high-pressure blading the roots are of T-section, fitting into grooves of corresponding shape turned on the periphery of the wheels. At the low-pressure end of the turbine where the blades are longer and the root stresses more considerable, a different design of root is employed. In this case the wheel rim is formed of T-section, and the blade roots are machined so as to straddle the wheel, the rim of which is thus embraced by the blade, instead of the converse arrangement adopted in the high-pressure wheels. Tangs are machined at the tips of all blades, by means of which the sections of shrouding are riveted on. Nickel steel is also used for the nozzle-plates, which are cast in position in the diaphragms. The discharge ends of the individual nozzles are cut out by a special machine, which acts somewhat in the manner of a shaper. It may also be mentioned that the back of each nozzle-plate is thinned to a fine edge, a practice the value of which has been endorsed by the recent report of the Steam Nozzles Research Committee.

AN EXTENSION OF THE MIDDLE THIRD THEORY.

By A. C. VIVIAN, A.C.G.I., B.Sc. (Eng.) Lond.

THE following theory was developed after the design of a number of reinforced concrete anchorages for a water power pipe-line.

Fig. 1.



The purpose of this article is to elaborate a general equation which, it is claimed, provides an easy and a safe approximation to the actual stresses existing under the base of an eccentrically loaded rigid rectangular foundation block.

Assumptions.—The foundation block is assumed to have been placed on undisturbed soil possessing both cohesion and friction between its particles. The ground is assumed to have yielded under the load until a position of equilibrium has been reached. In practice most of the yield will take place during the placing of the dead weight of the concrete; the additional yield under added external forces will be inappreciable if the calculated maximum earth pressure is kept by suitable design within safe limits as determined by tests of bearing capacity made at site.

The general equation which follows, applies to the normal component of the resultant, and the tangential component is supposed to be less than the resistance of the base to sliding, as in the case of the middle third theory.

The General Equation.—In Fig. 1 let GH represent a base of unit width and length $N = a\ (n + 1)$, divided by a normal force P in the ratio $n : 1$. The factor n may have any value not less than 1. When the block has subsided to a position of equilibrium, suppose that GFE represents the stress curve plotted along the base. The dotted straight line JK represents the corresponding stress distribution given by the middle third theory for the same position of the resultant. The general equation to the curve is:—

$$p = \frac{n \cdot p_c}{N^{n-1}} \cdot x^{n-1}$$

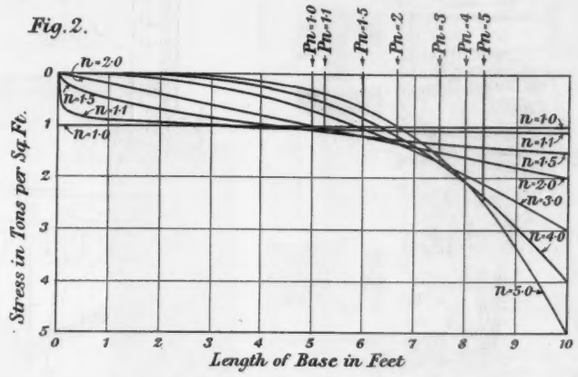
where p = stress at any point along the base
n = ratio of greater to less part into which the resultant divides the base
p_c = mean stress = resultant per unit width divided by area of base
N = length of base, $= a\ (n + 1)$
and x = distance along base measured from the heel.

This general equation satisfies the two following postulates:—

Postulate 1.—For all values of n, the area of the stress curve plotted along the base is a constant equal to the resultant per unit of width of base.

Postulate 2.—For all values of n, the sum of the moments of all forces to the left of the resultant is equal to the sum of the moments of forces to the right. In other words, the moment of the area GPF about P is equal to the moment of the area PHEF about P.

Fig. 2.



General Equation to Curves:- $y = \frac{n.p_c}{N^{n-1}} . x^{n-1}$
where n = *Ratio in which Resultant Force divides Base,*
N = *Length of Base of Unit Width,*
(8687.B) *and* p_c = *Mean Stress = Resultant ÷ Area of Base.* "ENGINEERING"

Fig. 3.

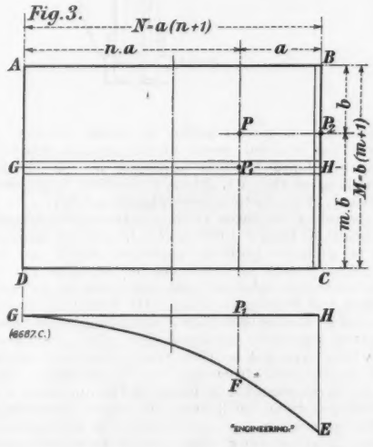


Fig. 4

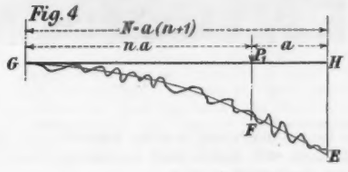
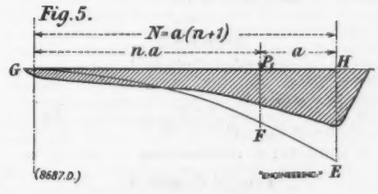


Fig. 5.



The Family of Curves.—For particular values of n, Fig. 2 gives some of the family of curves which satisfy the general equation. These have been drawn for a mean stress $p_c = 1$.

It will be seen that when $n = 1$, the graph is a straight line parallel to the base and distant an amount equal to the mean stress, in accordance with the usual assumption for rigid bases. When n lies between 1 and 2, the curves are concave with regard to the base and are almost straight along their major portion. When $n = 2$, that is when the resultant cuts the base at the limit of the middle third, the graph is a straight line identical with the accepted assumption of stress distribution. When n is greater than 2, the graphs are convex with regard to the base. For the value $n = 3$, Fig. 1 shows a comparison between the two methods of estimating the stress distribution. The general equation gives a maximum stress value in excess of the middle third method, but it is submitted that there is as much reason for supposing that the stress will gradually tail off to zero at the heel of the base as for considering it zero over a considerable length JG.

Advantage Claimed.—The advantage which is claimed for the general equation is that it gives the value $n.p_c$ for the maximum stress.

This is very simple to compute; and in the case of anchorages which are loaded eccentrically with respect to both axes of the base, this advantage is very great.

For example, suppose Fig. 3 represents the base of a foundation block loaded so that the resultant passes through the base at P. If the block ABCD were loaded at P_1, the mean stress along the outside strip BC would be $n.p_c$. And if the strip BC is loaded at P_2 instead of at H, the maximum stress would be at B and would be equal to the mean stress along BC multiplied by the factor m, *i.e.*, the maximum stress under this base occurs at B and $= n.m.p_c$.

Practical Considerations.—In the case of most foundations, some points along the base, due to local conglomerations of stones, will yield less than others. Fig. 4 shows a possible stress re-distribution due to this effect alone.

Also there is to be considered the tendency of adjacent portions of a bearing soil to be pushed out when one part is pushed in. It is submitted that within limits this effect would tend to reduce the slope of the stress curve by re-distributing the stresses. It seems impossible that the stress under a base resting on cohesive material can change suddenly at H, for instance, from a maximum value to zero.

Fig. 5 is an attempt to express graphically a possible stress distribution for a block which has subsided to a position of stability. The outside parts of the stress diagram would have to be transferred to the sides of the block through the medium of the surrounding soil. There is evidently a limiting value of slope which the stress curve may

ELECTRIC WELDER FOR STATOR WINDINGS.

CONSTRUCTED BY THE A.1. ELECTRIC WELDING APPLIANCES COMPANY, ENGINEERS, LONDON.

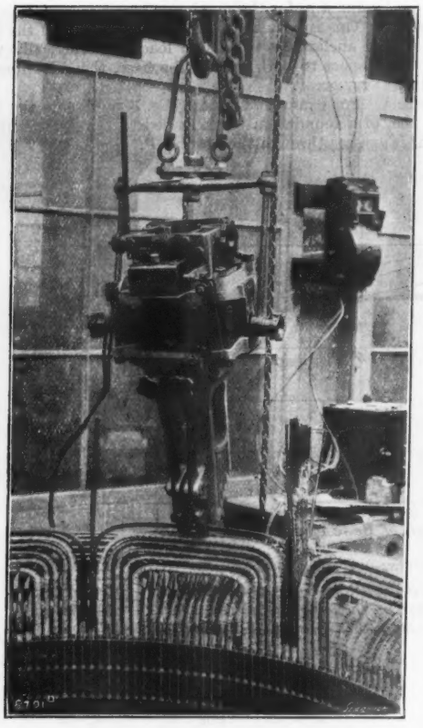


FIG. 1.

Fig. 2.

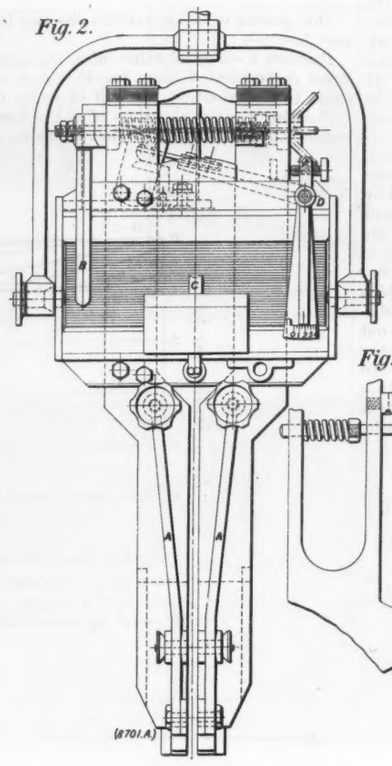


Fig. 3.

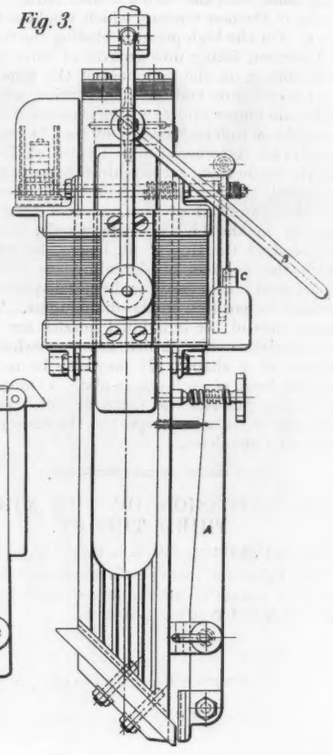
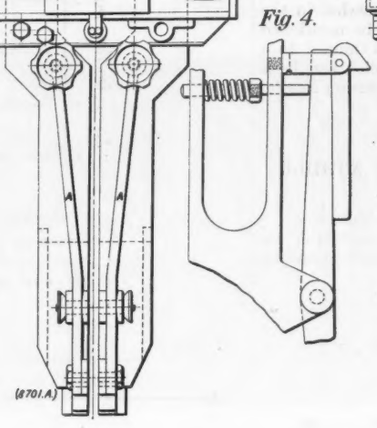


Fig. 4.



assume for any particular bearing material, and this limiting slope will decide that maximum allowable value for the factors m or n.

APPENDIX.

Proof of Postulate 1.

Area of curve

$$= \int_{x=0}^{x=a(n+1)} \frac{n \cdot p_c}{[a(n+1)]^{n-1}} \cdot x^{n-1} \cdot dx$$

$$= a(n+1) \cdot p_c \cdot = \text{resultant.}$$

Proof of Postulate 2.

Moment to left of P

$$= \int_{x=0}^{x=a \cdot s} \frac{n \cdot p_c}{a(n+1)^{n-1}} \cdot x^{n-1} (a \cdot n - x) \cdot dx$$

$$= \frac{a^2 \cdot p_c \cdot n^{n+1}}{(n+1)^n} \quad \ldots \ldots \quad (1)$$

Moment to the right of P

$$= \int_{x=a \cdot n}^{x=a(n+1)} \frac{n \cdot p_c}{a(n+1)^{n-1}} \cdot x^{n-1} (x - a \cdot n) \cdot dx$$

$$= \frac{a^2 \cdot p_c \cdot n^{n+1}}{(n+1)^n} \quad \ldots \ldots \quad (2)$$

And since I and II are identical, the general equation satisfies the second postulate.

THE A.1. ELECTRIC WELDERS.

AMONG the modern methods which have been placed in the hands of the works manager, there is probably none of greater value in its own sphere than electric welding. The convenience of the process in connection with repair work is now widely recognised, while it is rapidly taking its proper position in many lines of general manufacture. Electric welding has for many years been used for sheet iron construction of various kinds, and even in the manufacture of boilers. It has been adopted to quite a considerable extent for constructional steelwork and for assembling framework of very various kinds. Another sphere is in connection with electrical work, and an interesting example of such an application is illustrated in Fig. 1, above, which shows a special welder for stator winding in use at the Stafford works of the English Electric Company, Limited. This appliance is one of the specialities of the A.1. Electric Welding Appliances Company, of 64, Victoria-street, London, S.W.1.

This welder for stator winding is further illustrated in detail in Figs. 2 to 4, annexed. As will be seen this is an easily portable appliance, which can be slung from a crane jib in the manner shown in Fig. 1. It is carried on trunnions and can be swung in both vertical and horizontal planes. Its weight is 120 lb. The welder is operated from a regulating transformer mounted separately and provided with a six-way plug box, arranged so that more than one welder may be operated from the one transformer. The general arrangement and details of the appliance will be followed from the figures. It consists essentially of two aluminium legs, one of which is carried on a pivot. A transformer with a single-twin secondary is carried at the top of the legs and a pair of welding contacts are carried at the bottom ends. The secondary welding circuit passes from the transformer down one of the legs, through the weld up the other leg, across the flexible connection, which can be seen at the top of Fig. 2, and back to the transformer. This circuit is never broken, except, of course, by the removal of the piece of work which is being welded, and all control is on the primary circuit.

When a stator connection is to be welded it is clamped across the bottom end of the aluminium legs by means of the pivoted levers shown at A in Figs. 2 and 3. These levers are adjusted to clamp the connections by means of the screws with small hand wheels at the top ends. An alternative clamping arrangment with a cam lever is illustrated in Fig. 4. As will be seen from Fig. 3, the legs of the welder are furnished with heavy copper blocks at the lower end against which the wire to be welded is clamped. These blocks provide renewable contact surfaces and as they provide good heat conductivity, prevent undue local heating of the welder itself. At the top end of the legs of the welder there is a horizontal rod carrying a heavy helical spring which can clearly be seen in Fig. 2. This spring tends to force the top ends of the legs apart and so to close the welding gap, but the range of its action is limited by the nuts to be seen at the left-hand end of the rod in Fig. 2. By adjusting these nuts the width of the welding gap may be varied. The top ends of the leg may be closed together and extra pressure put on the helical spring by means of a cam operated by the lever B. The moving of this cam thus slightly increases the length of the welding gap. It is moved in this way before the wires to be welded are clamped in position by the levers A. The cam is then thrown over by the lever B and the pressure of the helical spring is applied to the job to be welded. When the job heats up as the current is switched on, the gap arms slightly close together under the action of the spring and a sound and satisfactory weld results, the amount of movement of the arms depending on the setting of the nuts at the left-hand end of the horizontal rod. The pressure of the spring may be adjusted by the wing nut at its right-hand end, to suit different sizes of material being welded. A scale is incorporated to indicate the setting of the spring.

The primary circuit of the welder passes through a press-button switch mounted on the front of it and indicated by the letter C in Figs. 2 and 3. The circuit also includes a switch arm carried on the pivot D of Fig. 2. This arm carries a contact block at its outer end which makes connection with a fixed contact mounted on the upper side of the transformer. The switch arm forms part of a T lever, as is clearly shown in Fig. 2. The lower arm of this lever serves as a pointer of an indicator, and the upper arm carries an adjusting screw the point of which sets against the side of the pivoted leg of the welder. The arrangement is set so that contact is made at the beginning of the weld when the press-button switch is operated, but as the weld closes in under the pressure of the spring the swinging of the pivoted leg moves the T lever and operates the switch in the primary circuit of the transformer. The whole arrangement can be adjusted to break circuit just at the right moment, and the scale allows the operator to set the welder to suit the particular job he is doing. The whole machine is very neat and handy and of great service for the particular type of work for which it is designed.

In addition to this specialised machine, the A.1. Electric Welding Appliances Company make a complete range of spot, butt and seam welders, some of which we also propose to describe.

From among these more general purpose machines we may first select a spot welder for treatment, as this is a comparatively simple type. It is

SPOT WELDER WITH ADJUSTABLE ARMS.

CONSTRUCTED BY THE A.I. ELECTRIC WELDING APPLIANCES CO., ENGINEERS, LONDON.

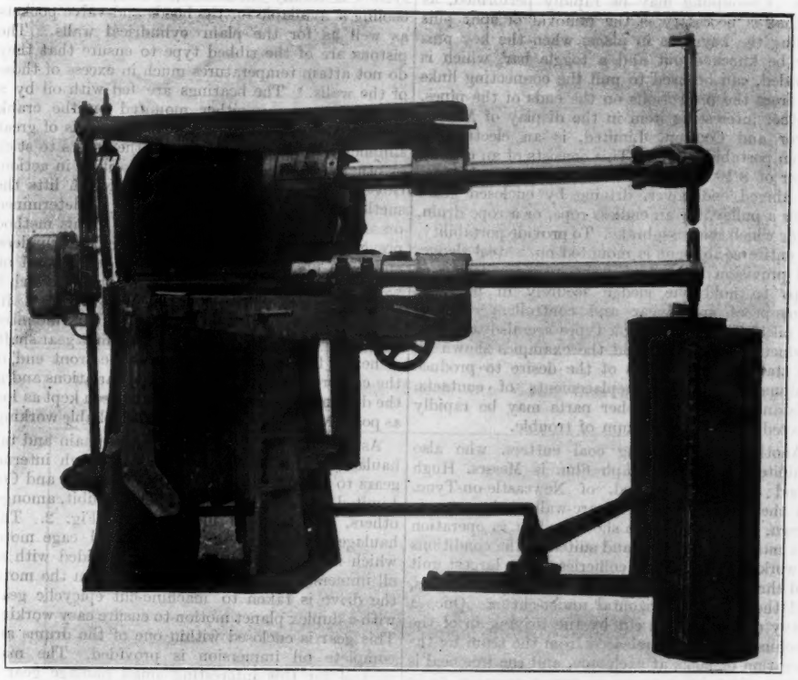


FIG. 5.

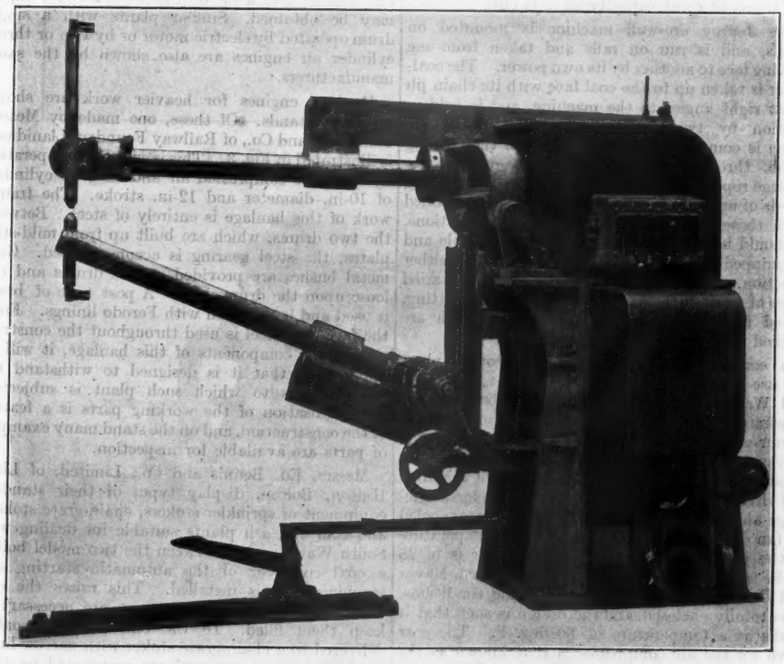


FIG. 6.

illustrated in Figs. 5 and 6. It is capable of dealing with a total thickness of $\frac{1}{2}$ in. of mild steel, that is two $\frac{1}{4}$ in. plates may be spot-welded together. As will be seen from the figures, the welder consists of a cast-iron body carrying the transformer, plug switch, &c., from which project two heavy copper welding arms. The welding electrodes consist of rods of hard-drawn copper of high electrical conductivity, which are adjustable endwise for wear. The arms and welding electrodes are water-cooled. The amount of projection of the arms from the main frame may be decreased, if necessary, to suit the work being dealt with. The lower arm may also be traversed up to 9 in. vertically and 4 in. horizontally, and may be canted up to an angle of 22 deg., as shown in Fig. 6.

When the machine is in operation pressure is applied to the welding tips by means of the foot pedal, which can be seen in the figures. On depression, this pedal first closes the electrodes on to the work and afterwards closes to main switch of the transformer. When a welding temperature is reached the switch opens, cutting off the welding current while, at the same time, the pressure applied to the weld is increased. The welding current and thus the heating effect may be controlled by means of the plug box, which can be seen in Fig. 6. This allows of eight different speeds of heating, to suit different classes and thicknesses of metal being welded. The transformer is oil-cooled, and one pole of the secondary, which is connected to the electrodes, is earthed to secure the operator against shocks. The maximum secondary voltage is 6 volts. It is found that after the welder has been in continuous operation for a prolonged period the temperature of the transformer does not exceed the temperature of the surrounding air by more than 60 deg. C. The transformer insulation will stand occasional overloads of 50 per cent. It is claimed that in the hands of a skilful operator the machine will carry out up to 200 welds per hour. Machines of this type have been supplied to the Admiralty for one of the naval dockyards and to several of the larger well-known shipyards. It has been found that the use of these machines reduces very considerably the cost of manufacture of air trunking and ventilator cowl work.

(To be continued.)

UNITED STATES PRODUCTION AND CONSUMPTION OF OIL.

STATISTICS now show that, in spite of her enormous oil fields, the United States consumes more than she produces. In January, 1922, the country was producing about 1,400,000 barrels daily; and in April of last year this figure had risen to 2,000,000, and was considerably in excess of this in the summer and autumn of 1923. Throughout this period, however, the average daily consumption has varied from 1,450,000 to 2,100,000 barrels. The daily difference between consumption and production has sometimes been 1,000,000 barrels. Only once has the position been reversed: between April and November, 1923, the country produced rather more than it consumed; after that production fell off again.

The situation has caused considerable anxiety; for its consequences are that the oil-producing companies bring great pressure to bear upon the administration for new concessions on oil-producing lands which have been treated as reserves for purposes of national defence. The controversy recently came to a head when Captain John Halligan, of the United States navy, drew public attention to the encroachments which were being made by private companies on the naval oil reserves of the Tea-pot Dome fields. Captain Halligan claimed that concessions had been granted to the Sinclair interests which would drain the Tea-pot Dome estate, and so deprive the navy of a large proportion of supplies which ought not to be touched. He considered the situation the more dangerous in that experts calculated that the United States had only 20 years' oil supply underground, after which it would depend on overseas supplies. He further argued that an administrative change had made the navy's control over its oil supplies insecure. "Until May, 1921, the naval petroleum reserves were administered by the Navy Department, with such assistance as was required from the Departments of Justice and the Interior. Soon after the naval petroleum reserves were turned over to the Department of the Interior, with the result that "there has been effected a radical change of policy from conservation to exploitation under conditions which prevented the presentation of arguments against such a change of policy. These arguments would, I believe, have been conclusive."

The correspondence provoked a long and detailed answer from the Secretary to the navy. He stated that the administrative change had been necessary, in that the Department of the Interior had custody of over 6,000,000 acres of Government oil lands, and that it was, therefore, proper that the naval oil reserves of rather more than 200,000 acres should be administered by them as well. The remainder of his letter seemed in great measure to justify Captain Halligan, for an expert from the geological department admitted that the development on the north-western boundary of the naval reserve would ultimately drain the reserve itself. In these circumstances, the Secretary of the navy urged that the only policy to pursue was to get as much oil as possible out of the Tea-pot Dome reserve, by exploiting it in time.

The controversy provoked some interesting opinions about British oil policy. Groups of American senators seem to think that, whilst America is squandering resources which are essential to her national defence. Great Britain is slowly absorbing the world's supplies. As the Secretary of the navy admitted that America's oil supply must be adjusted for "probable campaigns in the Atlantic and the Pacific," this, naturally, causes anxiety. Statistics do not, however, confirm what the American senators have stated so emphatically. During 1923, Great Britain consumed about 5,000,000 tons of oil and imported rather more than half of this amount from America.

THE CARDIFF ENGINEERING EXHIBITION.

That small specialised exhibitions are of great value to manufacturers was clearly indicated by the statements of many exhibitors at the opening of the Cardiff Engineering Exhibition, on Thursday, November 27. After the Lord Mayor of Cardiff, Alderman Pethybridge, and Mr. W. A. Chamen, the President of the South Wales Institute of Engineers, had delivered addresses of welcome, the exhibitors were asked to give expression to their opinions of the value to trade of such shows. Mr. A. W. Bennis, of Messrs. Edward Bennis and Co., Limited, Bolton, in reply to this invitation, spoke of the many advantages to the manufacturers of participation in specialised engineering exhibitions and referred to the experiences of his own firm. The outstanding advantage was that they not only got into touch with potential buyers, but also with the foremen and workmen, who had experience of the running of their plants. Mr. Bennis was followed by six other speakers, who showed clearly that his experience was not an isolated one, and they emphasised the points that he made in his speech. All spoke in highly eulogistic terms of the thoroughness with which the Cardiff Engineering Exhibition was organised by the Council of the South Wales Institute of Engineers, and its secretary Mr. Martin Price. It is, however, to be regretted that Cardiff does not possess a single large hall, such as would accommodate all who desire to participate in the display, without cramping the exhibits and leaving but little space for the visitors. When the formal opening of the Exhibition took place, on Thursday, November 27, every stand was completely ready for inspection and business was immediately possible.

This exhibition, naturally, is mainly of a mining engineering character, and its importance at the present time, when everything possible must be done to reduce the cost of winning coal, may be judged from the way in which it has, so far, been visited by the people concerned with mining developments in the South Wales district. There is little to interest the general public and, consequently, very little of the demonstrator's time is wasted in dealing with the enquiries of people who have no real interest in the machinery displayed. The exhibits are mostly shown in three halls, but a 20-ton all-steel mineral wagon had to be accommodated outside. This is the first all-steel wagon of its size to be built in South Wales. It is a product of The Cambrian Wagon Company, Limited, of East Moors-road, Cardiff, and it was built to the Railway Clearing House Specification of July, 1924, and has been registered by the Great Western Railway Company for main-line traffic. The wagon has two side and two end doors and is arranged for tipping at either end. This wagon has a wheel base of 12 ft. and a length over headstocks of 21 ft. 6 in. The tare weight of the wagon is 9 tons 5 cwts. There is a growing popularity for this size of wagon in the South Wales coalfield, and the Great Western Railway Company now offers a rebate of 5 per cent. off the railway rates for coal conveyed over their system in wagons of this capacity.

Coal-cutting machinery in variety, of the bar, chain, arc-wall and disc type, is shown by Messrs. Mavor and Coulson, Limited, of 47, Broad-street, Mile End, Glasgow. The characteristics of these machines are familiar to readers of Engineering from a description we gave of them in a recent article (see vol. cxv, pages 614 and 648), and also from the description of the equipment of the Model Mine at the British Empire Exhibition (see current volume, page 225). To ensure that those unfamiliar with the work that is possible with these machines might study their action, Mr. Ward, of Messrs. Mavor and Coulson, Limited, exhibited a cinematograph film on Friday morning in the Institute Hall, and this will be repeated to-morrow, Saturday, evening. In addition to coal cutters, examples are shown of other manufactures of the firm, including the "Gullever" hose couplings, band-type conveyors driven by electric motor or air turbine, and flame-proof switchgear. The "Gullever" hose coupling was designed to meet the requirements of supplying compressed air to machines at the coal face. The joint is a spigoted one with the two components held tightly against each other by double-connecting links at two sides, which are drilled to accommodate pins which also pass through projections on the pipe ends. Uncoupling may be rapidly performed, as all that is necessary is the removal of split pins holding the key pins in place, when the key pins may be knocked out and a toggle bar, which is provided, can be used to pull the connecting links free from the projections on the ends of the pipes. Another interesting item in the display of Messrs. Mavor and Coulson, Limited, is an electrically-driven portable hauler. This consists of an electric motor of 8/10 h.p., with its switch enclosed under the hinged end cover, driving by enclosed gears either a pulley, for an endless rope, or a rope drum, beside which there is a brake. To provide portability, the entire equipment is mounted on a steel sledge, and provision is made for the accommodation of props to hold the sledge securely in position. Flame-proof switchgear and controllers of both the oil break and air-break types are also standard products of this firm, and the examples shown on the stand give evidence of the desire to produce equipment in which replacements of contacts, resistance units, and other parts may be rapidly effected with the minimum of trouble.

Another firm showing coal cutters, who also exhibited a cinematograph film, is Messrs. Hugh Wood and Co., Limited, of Newcastle-on-Tyne. On their stand a Jeffrey arc-wall coal cutter is shown, but the film also showed plant in operation of a much heavier type and suited to the conditions of working in American collieries. The largest unit had three cutting chains, two vertical side-chains, and the other a horizontal under-cutter. Once a heavy cube has been cut by the driving in of the machine, the coal is released from the seam by the operation of jacks at each side, and the free coal is then broken by a series of power-operated picks mounted on a heavy frame. This machine has a conveyor under it to remove the coal and load it into trams of great capacity as it is cut.

The Jeffrey arc-wall machine is mounted on wheels, and is run on rails and taken from one working face to another by its own power. The coal-cutter is taken up to the coal face with its chain jib set at right angles to the machine, and is held in position by two simple jacks. The chain jib, which is commonly 7 ft. 6 in. long, is then swung round, through a half-circle by the use of the haulage rope, cutting into the coal face. Traversing speeds of up to 60 ft. per minute have been obtained with these machines under suitable conditions. It should be noted that the chain is reversible and is equipped with picks that cut equally well in either direction. These machines are capable of varied types of work, such as under, over or middle cutting, suited to the thickness of the seams which are worked upon and other conditions.

A complete air-compressing and storage plant for use underground is shown by Messrs. Broom and Wade, Limited, of High Wycombe. This is illustrated in Fig. 1, on page 767. It is mounted on a four-wheeled carriage, of 11 ft. length, for easy movement to the place of use, and the equipment consists of a totally enclosed motor with a starter and driving through gearing a two-cylinder single-stage air compressor, while there is a radiator cooled by fan draught installed to reduce the temperature of the jacket water. The electric motor is of 28 brake horse-power, and was made by Messrs. Mavor and Coulson, of Glasgow, to suit mine conditions. It is totally enclosed, and the design is such that it works at a temperature of 80 deg. F. The gear drive for the air compressor is that known as the "Typhoon" and consists of a single reduction by the use of double helical gear wheels. Stresses due to the twisting of the frame are minimised by making the gearing and compressor a self-contained unit. Hyatt roller bearings are provided for the shafts of the gear wheels. The compressor is of the double-cylinder type with 7-in. diameter cylinders and 8-in. stroke and is run at 420 r.p.m. Mechanically operated suction valves are provided which receive their motion from a wiper type of cam, which is moved by a lever system operated from the big end of the connecting rod. The delivery valve is of the plate type and mounted directly above the inlet valve, and is arranged so that it may be readily removed for inspection or for taking out the inlet valve. Everything in the design of the compressor is of a simple and robust character, and all the moving system is totally enclosed and dustproof. Water-cooling is available for the heads and valve pockets as well as for the plain cylindrical walls. The pistons are of the ribbed type to ensure that they do not attain temperatures much in excess of those of the walls. The bearings are fed with oil by a rotary gear pump either mounted on the crank shaft or belt-driven from it. The pump is of great simplicity, having no valves or other parts to stick or otherwise give trouble, and is positive in action. Governing is effected by a device which lifts the suction valve from its seat when a predetermined pressure is attained in the receiver. This method prevents the formation of a vacuum in the cylinders, and thus prevents an unnecessary quantity of oil being drawn past the piston rings. The air which is compressed is delivered to a receiver of 2 ft. diameter and 3 ft. 6 in. long, which is mounted above the coupling of the motor and first gear shaft. A heavy flywheel is provided at the front end of the compressor to reduce the speed variations and in the design the bearing stresses have been kept as low as possible to obtain continuous and reliable working.

As an example of a handy type of main and tail haulage having an electric drive through internal gears to the drums, Messrs. David Ashton and Co., Limited, of Aztec Works, Sheffield, exhibit, amongst others, the machine illustrated in Fig. 2. This haulage is driven by a 5-h.p. squirrel cage motor which is totally enclosed and is provided with an oil immersed flame-proof starter. From the motor the drive is taken to machine-cut epicyclic gears with a duplex planet motion to ensure easy working. This gear is enclosed within one of the drums and complete oil immersion is provided. The main control for this interesting small haulage gear is obtained by the use of a hand-wheel controlled expanding type of friction clutch By the use of this haulage gear a speed of between 2 and 3 m.p.h. may be obtained. Similar plants with a single drum operated by electric motor or by two or three-cylinder air engines are also shown by the same manufacturers.

Haulage engines for heavier work are shown on many stands. Of these, one made by Messrs. John Mills and Co., of Railway Foundry, Llanidloes, is illustrated in Fig. 3. This is suitable for operation by steam or compressed air and has two cylinders of 10-in. diameter and 12-in. stroke. The framework of this haulage is entirely of steel. Between the two drums, which are built up from mild-steel plates, the steel gearing is accommodated. Gun-metal bushes are provided on the drums and run loose upon the drum-shaft. A post type of brake is used and is provided with Ferodo linings. From the fact that steel is used throughout the construction of the components of this haulage, it will be appreciated that it is designed to withstand the heavy duties to which such plant is subjected. Standardisation of the working parts is a feature of the construction, and on the stand many examples of parts are available for inspection.

Messrs. Ed. Bennis and Co., Limited, of Little Hulton, Bolton, display types of their standard equipment of sprinkler stokers, chain-grate stokers, and coal and ash plants suitable for dealing with South Wales coal. Between the two model boilers a coal conveyor of the automatic starting and stopping type is installed. This raises the coal to the hoppers at such times as are necessary to keep them filled. To the one side the coal is delivered to a chain-grate stoker with narrow links. These links are cast, and are corrugated on their sides and held in association with each other by dowel pins. By the use of narrow links a large proportion of the area of the grate is available for the passage of air through the fuel bed, and the cooling of the grate is rendered much more effective. Efficient combustion of inferior coal is also made possible, and variations in the quality of the fuel or in the demands upon the boiler are met by the provision of a six-speed gear for the grate. The conditions that are necessary for working with South Wales coal are therefore completely met and the equipment is designed for

THE CARDIFF ENGINEERING EXHIBITION.

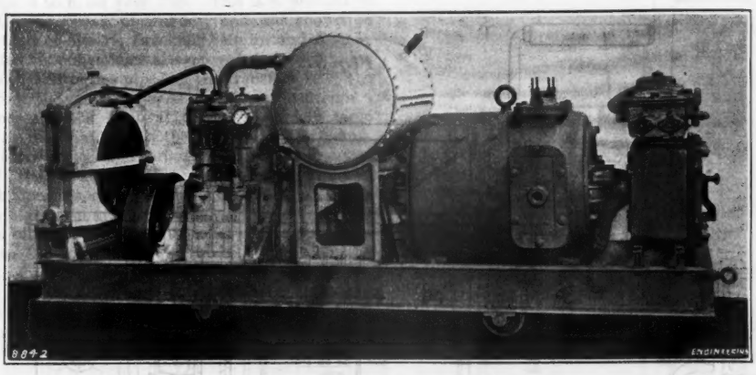


FIG. 1. PORTABLE AIR COMPRESSOR; MESSRS. BROOM AND WADE, LIMITED, HIGH WYCOMBE.

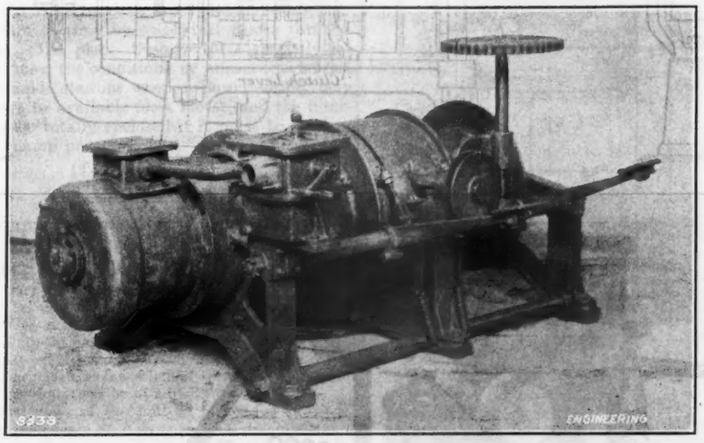


FIG. 2. 5-H.P. MAIN AND TAIL HAULAGE; MESSRS. DAVID ASHTON AND CO., LIMITED, SHEFFIELD.

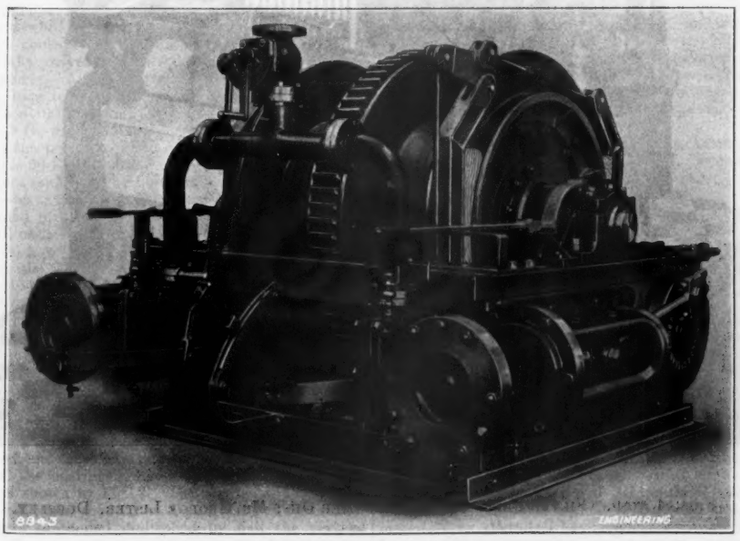


FIG. 3. COMPRESSED AIR OR STEAM HAULING ENGINE; MESSRS. JOHN MILLS AND CO., LLANIDLOES.

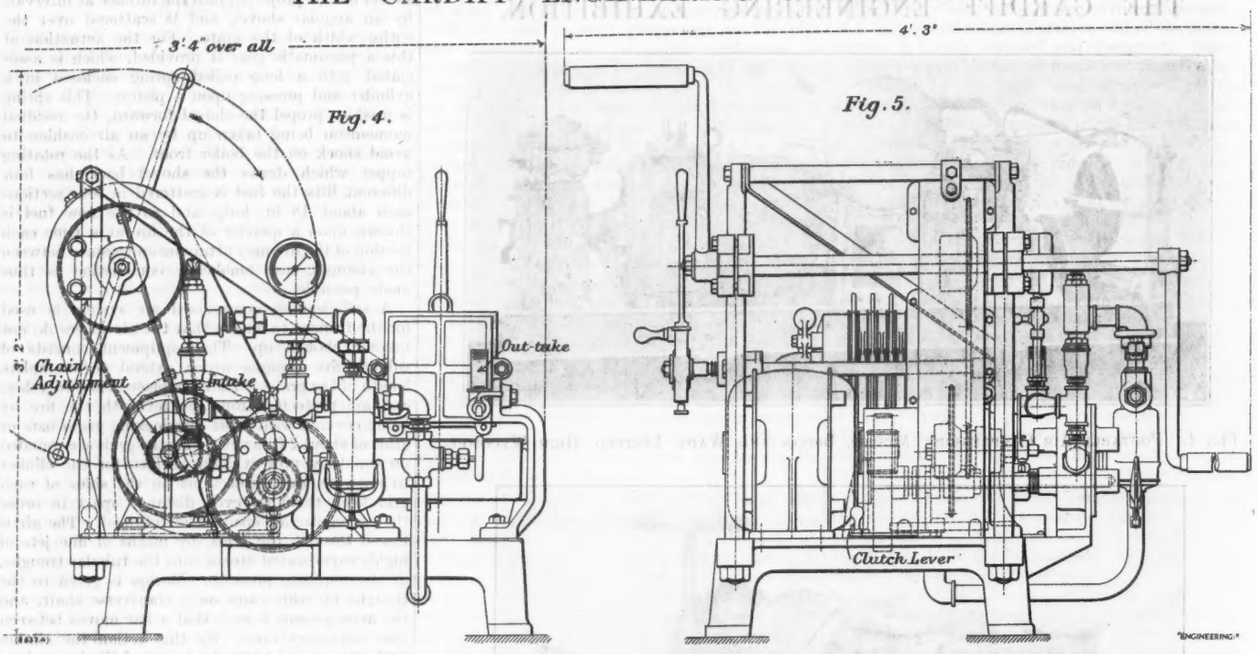
heavy and continuous service. The second boiler is equipped with the well-known Bennis sprinkler stoker. In this the fuel falls from the hopper in front of a pusher plate, and is forced over a ledge formed by the bottom of the feeding box. The amount of coal thus pushed over can be regulated by means of an adjustable cam on the driving shaft, all that is necessary to change the conditions being the turning of a hand nut while the machine is running. Adjustment is thus possible in a gradual way through a very wide range and suited to deal with coals of very varying characteristics. The coal that falls on the flat plate, known as the shovel box, is projected into the furnace at intervals by an angular shovel, and is scattered over the entire width of the grate. For the actuation of this a pneumatic gear is provided, which is associated with a long coiled spring enclosed in a cylinder and pressing upon a piston. This spring is used to propel the shovel forward, the residual momentum being taken up by an air cushion to avoid shock on the boiler front. As the rotating tappet which draws the shovel back has four different lifts the fuel is scattered in four sections each about 18 in. long, and as the new fuel is thrown upon a quarter of the fire at a time each portion of the fire may attain incandescence between the changes, and smokeless combustion is thus made possible.

A self-cleaning compressed air system is used for the furnace to ensure that the air spaces do not become choked up. This equipment consists of tubular fire troughs which extend the complete length of the grate. They are placed close together, and are protected from contact with the fire by being covered with short interlocking grate bars or grids of about 2 ft. length. As the grids are rounded on top they present little surface for the clinker to stick to, and projections on the sides of each grid keep them an even distance apart in order that a regular air space is maintained. The air is forced through the grids, by means of fine jets of highly superheated steam into the tubular troughs, at the requisite pressure. Motion is given to the troughs by wide cams on a transverse shaft, and the arrangement is such that a bar moves between two stationary ones. By this action the clinker is slowly carried to the back end of the bars where it is dropped into a closed chamber from which it can be removed when necessary.

Amongst the exhibits of the Underfeed Stoker Company, Limited, of Aldwych House, Aldwych, London, there is an example of a travelling grate stoker for natural or induced draught. In this, the grate is composed of very narrow steel stampings and may be regarded as more of the nature of a laminated belt than a chain. A large proportion of the grate area is, therefore, available for the passage of the air through the fuel bed, while the distances between the links are small. In place of the common sprocket drive for the grate, a fluted drum at the front is used and the lower part of the grate is allowed to hang free, without supporting rollers, and to dip into a water bath. Two purposes are served by this arrangement, a perfect air seal is obtained and the subdivision of the air space is made possible by the insertion of vertical plates, so that the air delivery to different parts of the furnace may be regulated to suit the combustion requirements. An obvious advantage of the water bath is that the grate is kept cool under the heaviest working conditions. As the grate is arched, the back can be given a decline to make the action of depositing ash and clinker quite positive. In this type of stoker an arrangement of alternately-inclined rollers, which are flanged, makes the individual members forming the grate surface tend to move closely to their neighbours, while provision for expansion is available at each side of the grate. This stoker may also be provided with cast-iron links with projections on the sides to ensure that the air spaces are kept uniform. In both types the grate is self-cleaning, as the relative movements of the links, as they pass over the front and back drums, shake out any obstructions to the passage of air. At the top of the furnace in the model at the Exhibition, a Detrick-Usco flat arch is provided. Other items on the stand are a model of a pulverised fuel plant for the Lopulco system of firing powdered coal and an actual air heater element for the Usco system of raising the temperature of the air supply to the furnace.

The method of obtaining even air pressure throughout a fuel bed by the use of troughs of continuously diminishing area, as applied by the Turbine Furnace Company, Limited, of 238B, Grays Inn-road, London, is well shown by the use of models. In this furnace the grate is split up into a number of separate units. Records are shown by the company of the results obtained with the system in use. Another interesting feature on the stand is the Vulcan mechanical soot blower. For

THE CARDIFF ENGINEERING EXHIBITION.



this a manifold valve is provided by means of which steam from the boiler may be passed in turn through a series of pipes with nozzle ends. By blowing the dust from the tubes by a regular sequence of operations it is finally discharged, usually at the chimney-top. The removal of dust in this way once a day, makes possible the keeping of all surfaces of tubes, superheaters, economisers, &c., free from heat-resisting material.

Another appliance of importance to boiler users is the Filtrator, shown on the stand of Messrs. Haslam and Stretton, Limited, of 11, Windsor Place, Cardiff, by the use of which hard water may be used as boiler feed without the accumulation of deposit on the heat-transmitting surfaces. A full description of this appliance and its working was given in ENGINEERING recently (see vol. cxvii, page 623).

Messrs. H. and T. Danks (Netherton), Limited, of Netherton, Dudley, who specialise in Lancashire and Cornish boiler and tank construction, show the front of their standard Lancashire boiler complete with all the usual fittings and mounted on a glazed brick setting. Beside this, Dee Superheaters, Limited, of Bishtons Bridge, Netherton, an associated company, show examples of the construction of expanded-tube type and union-jointed sectional-type superheaters. In the expanded-tube type the headers are made with a curved underside and a flat top, in which the hand-holes are drilled. By this construction no less than eight tube ends can be conveniently expanded through each hand-hole. For high temperatures the tubes connect between two headers, and thus an inner and an outer series of U-tubes are used. When the requirements are less, a single header with division plates is used, and the tubes are then mounted in line with the headers. In the union-jointed, sectional type of superheater each tube is a unit, and its ends are curved over for connection at the top of the header. These connections provide a true seating for the tube couplings and are screwed into the headers. The couplings may have conical metal-to-metal tail-pieces or flat tail-pieces with jointing material in place. Replacements, or the blanking off of connections, when new tubes are not available, is possible in a few minutes, as, apart from removing the cover, the only work necessary is the removal and replacement of two nuts.

Superheater Units, Limited, of 4, Castle-square, Swansea, exhibit examples of their design of superheaters, in the general type of which the tube has three bends, giving four passes for the steam, and the ends are brought close to each other for connection to the header at the top. The tube elements are attached to the headers by means of simple clamps, each pair of which is held by a single bolt which passes through the space between the two inlet and outlet headers. Short-circuiting loops may be quickly introduced in place of a tube element when it is necessary to reduce the amount of superheating. Other designs in which the similar requirements are met, are available for locomotives and fire-tube boilers generally.

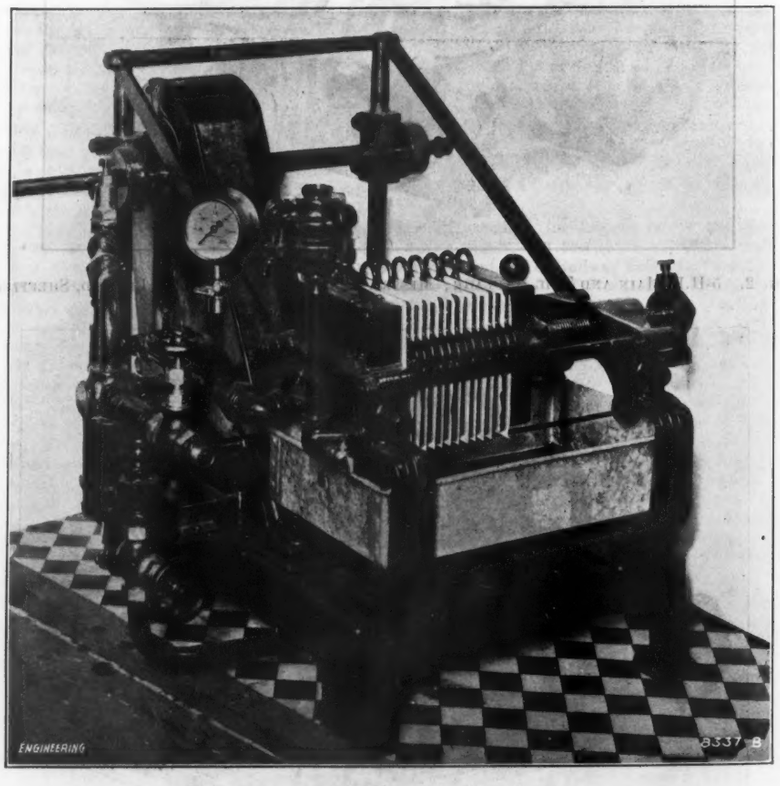


Fig. 6.

Figs. 4 to 6. Filter Press for Transformer Oil; Mr. George Lister, Dursley.

In the treatment of transformer oil to preserve its insulation properties, centrifugal separators and filter-presses are in common use. While each system has its advocates, there are situations where space is suited more to the one than the other. The removal of any floating matter, water, or acid that may be present in the oil is essential, for it is a characteristic of all such impurities that they tend to collect in the spaces between parts of the electrical plant which have electrical potential differences and cause a reduction of resistance,

which might not be anticipated from the small quantity of impurity present. A simple and effective hand or motor-operated filter press is illustrated in Figs. 4 to 6, on page 768. This is a product of Mr. George Lister, of Dursley, and was shown on the stand of Messrs. Brecknell, Munro and Rogers, Limited. Connections are provided for coupling to inlet and outlet pipes on the transformer. The oil from the transformer is first drawn through a strainer for the removal of comparatively large floating material, and is then passed to the pump. This is driven by hand through a double-chain drive, which is provided with a chain-adjusting device which operates on both chains at once. A small electric motor may also be used to drive the pump, and a clutch is available to bring either drive into action. As the pressure of the oil is raised in the pump, the oil is forced through the filter press. This has a series of grids, each pair of which is separated by five thicknesses of a special filter-paper of great toughness and density. In the passage through the filter all moisture and acids are rapidly removed, and the oil is delivered back to the transformer in a condition suited to the requirements.

Although small, the plant is efficient, and the resistance characteristics of transformer oil may be maintained at all times at small cost and with little expenditure of time by occasional passes through the press. The plant illustrated was specially designed to meet the conditions in mines, iron works, and in outside stations where a power supply may not always be available for a motor, and the filter-box may be totally enclosed if it must be used in a wet or damp place.

(To be continued.)

LETTERS TO THE EDITOR.

MICHELL JOURNAL BEARINGS APPLIED TO COLD ROLLS.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to the series of articles that have been appearing in your paper upon the subject of "Roll Bearings for Cold Rolling Mills," the result of fitting bearings on the Michell principle for this purpose will doubtless be of added interest.

The particulars of the mill to which the bearings have been fitted are as follows: Rolls, 15 in. diam.; necks, 10 in. diam.; speed, 30 r.p.m.; the mill rolls bronze strip, 2½ in. wide; the reduction per pass ranges from 0·04 in. up to in some cases 0·13 in.

The ordinary bearing brasses, which were replaced, measured 9 in. in length and embraced the 10-in. journal over an arc of 120 deg. They were lubricated with olive oil and cooled by a trickle of water. The mill is electrically driven and fitted with a gauge showing horse-power. A fuse is fitted to blow at 100 h.p. The bronze bars to be rolled are put through the mill in batches of 100 or more. The initial length of the bar is about 2 ft. and thickness ½ in. With the ordinary brasses the power required at starting to roll a batch of bars is 50 h.p. to 60 h.p., which gradually increases, and, to avoid the fuse blowing, either part of the nip had to be taken off during the rolling, or the rolling suspended until the bearings cooled. Running light, the mill used 7 h.p., and the average when loaded was about 90 h.p.

With the Michell bearings now fitted the power required varies from 40 h.p. to 65 h.p., according to the amount the bar is reduced. In a test taken over 10 batches of bars the average power absorbed was 50 h.p., the gauge showing a steady reading throughout the rolling for any given reduction of thickness to the bars rolled, thus giving a saving in friction of about 40 h.p. The new bearings, which are illustrated in Figs. 1 and 2, annexed, are lubricated with a heavy oil supplied by means of a pump, driven from the free end of the lower roll by a chain belt. No cooling is provided, and there is no perceptible rise in the temperature of the bearings. Each bearing has two pivoted pads, as shown in Fig. 2. The load is supported by radial reactions, that on each pad being the secant of the angle subtended multiplied by half the vertical load. The principle on which the pads act is the same as in the case of the well-known Michell thrust bearing, which may be looked upon as a journal bearing applied to a shaft of infinite radius.

Some little trouble was experienced at first in preventing leakage of oil owing to the oil drains being too small, but this has been got over.

The chief difficulty in applying these bearings to existing mills is lack of sufficient space in the housings, in which to provide parts of sufficient strength to resist the heavy stresses, but in new mills, where the housings can be made to suit the new design of the bearings, it is quite practicable to ensure true pressure oil-film lubrication, with its correspondingly very much lower friction, as against the mere greasy friction that obtains in bearings of the ordinary type.

Apart from the saving in power, an important advantage with these bearings is that the higher the speed the greater the pressure the bearing pads will carry, whereas with the ordinary brasses, owing to their much higher coefficient of friction, heat is generated too rapidly to allow of high speeds.

Yours faithfully,
MICHELL BEARINGS, LIMITED,
Per H. T. NEWBIGIN.

Newcastle-on-Tyne, November 13, 1924.

"THE DETERMINATION OF STRESSES BY OPTICAL METHODS."

TO THE EDITOR OF ENGINEERING.

SIR,—Professor Jasper, in his letter which you published in your issue of November 21, does not withdraw his earlier statement that optical measurements of the stress around a hole in an isotropic elastic plate are twice as great as they should be, although these measurements are confirmed by the exact solutions of the theory of elasticity. All his arguments based on overstressing and fatiguing crystalline materials dynamically or otherwise, fail to show that these measurements are incorrect and he does not in fact attempt to prove his case.

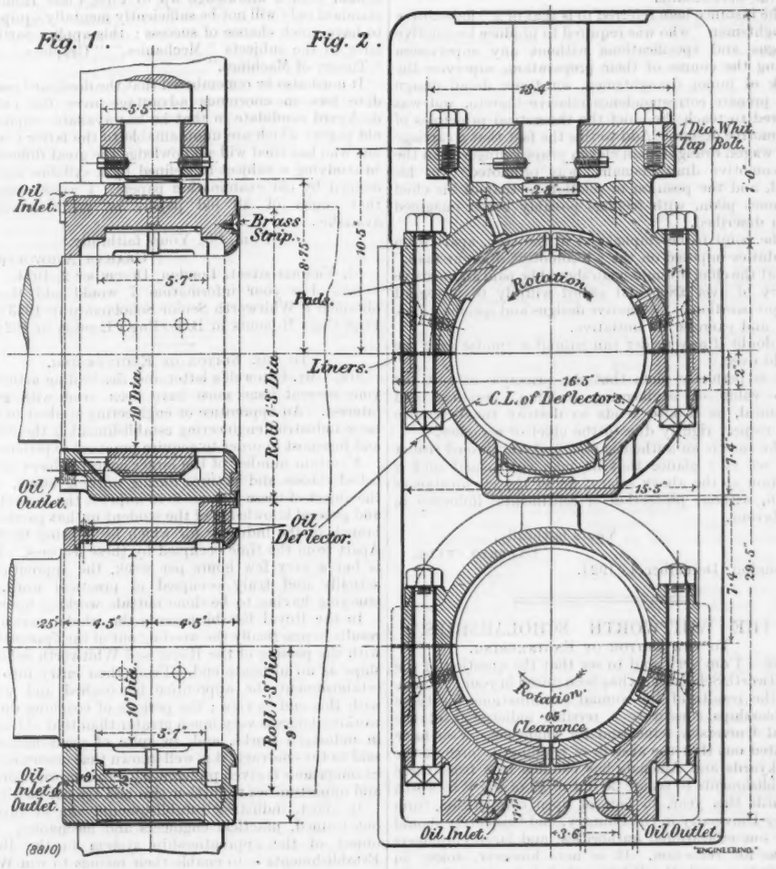
He further charges me with taking up the attitude that there is only one method of analysing stresses in materials, an attitude I have never taken and, in fact, I have published several papers on stress distribution, in which strain measurements and thermo-electric observations are freely employed.

Professor Jasper stated at Toronto, as reported in your issue of August 29, p. 284, that he "believed we were on the eve of a method of determining stresses which would not depend at all on optical principles," and presumably there has now been sufficient time for this new method to be developed sufficiently for publication. I therefore now ask him to tell your readers what this method is, so that everyone can judge for himself how far his statements are justifiable. If it is all he states, I shall only be too happy to use it.

Yours faithfully,
E. G. COKER.

University of London, University College, Gower-street, London, W.C.1.
December 1, 1924.

MICHELL JOURNAL BEARINGS FOR COLD ROLLS.



"THE EXTENT OF CAVITATION IN U.S. SCOUTS AND DESTROYERS."

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to this paper in your issue of November 21, the reference to air drawn down the after edge of stern tube bracket arms or propeller struts, is very interesting, and one is inclined to agree with the opinion of the writer. In the case of a launch with which the writer was concerned, and which was engined by his firm, this drawing down of air actually took place, and caused very irregular propeller action. The writer (warned by the case of the Daring) thought at first that increased blade surface would probably cure the difficulty, but this was found not to be the case, and further examination elucidated the matter. When the bracket arms were altered and attached to the stern, in such a position as to be submerged entirely, no further difficulty was encountered and good performance secured. The launch was 65 ft. by 8 ft. 3 in. and attained a speed of about 24 miles.

Yours faithfully,
W. SISSON.

Gloucester, December 1, 1924.

THE REMUNERATION OF TECHNICAL MEN.

TO THE EDITOR OF ENGINEERING.

SIR,—From time to time cases have been put forward of highly trained technical men in the engineering profession being underpaid for the services demanded of them. In the hope that you will kindly extend to me a little space in your valuable columns, I would like to give an instance which presents the opposite point of view to the above.

It is universally accepted that the position of chief draughtsman in any drawing office is held by a man of proved experience in his branch of engineering

able to advise, discuss, guide and properly supervise the work in hand, with the necessary prudence and tact required to manage the staff under his charge to get the best results.

The instance here referred to is that of a "locomotive draughtsman" who was required to produce locomotive designs and specifications without any supervision during the course of their preparation, supervise the work of junior draughtsmen, scrutinise detail design and prepare correspondence relative thereto, and was desired to teach the chief the theoretical principles of locomotive design. Add to this the fact that a carriage and wagon draughtsman eleven years younger than the "locomotive draughtsman" was promoted over his head, and the position in relation to that of his chief becomes plain, with feelings possibly better imagined than described.

The point to be emphasised in the case, apart from the duties imposed on the "locomotive draughtsman," is that the chief draughtsman should be paid an inclusive salary of over £800 and afford wilfully to disregard the preparation of locomotive designs and specifications, &c., and exercise no initiative.

I doubt if any reader can submit a similar case the world over.

It is perfectly plain that the principle cuts at the root value of engineering training, practical and technical, as it also tends to destroy the deference and respect rightly due to the chief of an office.

The case is an authentic one, and the shrewd reader will see at a glance that no man could hold such a position at the above salary, under the circumstances given, without protection or sentimental influence in his favour.

Yours faithfully,
EXPERTO CREDE.

London, December 1, 1924.

"THE WHITWORTH SCHOLARSHIPS."

To the Editor of Engineering.

SIR,—I am very glad to see that the question of the Whitworth Scholarships has been raised in your columns, for the results of the annual examinations for these Scholarships constitute a terrible indictment of the usual University education for engineers. You have pointed out that the system of training in force at the Dockyards and Arsenals has enabled lads from these establishments to secure 30 out of 33 of the Whitworth Awards this year, in face of open competition from every University in the Country, and this surely should give our educational authorities, and large employers cause for reflection. It is not, however, solely in connection with the Whitworth Scholarships that the Dockyard system is so successful. The recently published list of winners of the Royal Scholarships (Science) show an even more striking tribute to the system. Eight Royal Scholarships and two Free Studentships in Engineering were awarded this year. There were 102 competitors, but every one of the successful ten was a Dockyard boy. Not a single candidate from any civilian engineering establishment in the country is to be found in the list of winners.

The fact that none of our engineering works, technical schools or universities can apparently turn out men with the training and education given in the Dockyard Schools is worth the serious consideration of all those who are concerned with the future of the engineering industry. Very few lads can possibly have the chance of entering a Dockyard, and it is most important that an equivalent education should be rendered accessible to all. The result of the present system is seen in almost every branch of engineering. Although the steam turbine, practically speaking, originated in this country, I can count about a dozen firms who have gone abroad for their designs preferring to manufacture some hyphenated machine under license, rather than to get out one as good or better for themselves. The same sort of thing has been going on with oil-engines, centrifugal pumps, hydraulic turbines, &c., and it is having a serious effect in our foreign trade, as foreign buyers naturally have more confidence in manufacturers who originate rather than copy designs.

Yours faithfully,
M.I.Mech.E.

To the Editor of Engineering.

SIR,—All with the good of the name "Whitworth Scholar" at heart will be grateful to Mr. Ottewell for his recent letter to you on this subject.

I should like, however, as a recent candidate, to emphasise the great difficulty in obtaining teaching of an advanced enough character, unless the student has the good fortune to attend a dockyard school.

Before the new regulations came into force, it was compulsory, amongst other things, to pass in "Solid Geometry and Graphics," and in this subject there was, to my knowledge, no class—certainly no evening class—in London which was of much assistance to a prospective candidate.

A comparison of the new syllabus and papers for Senior Scholarships with, say, the London University syllabus for Final Engineering, will show at once that a man with a knowledge up to First Class Honours standard only will not be sufficiently mentally equipped to have much chance of success; this applies particularly to the subjects "Mechanics," "Graphics," and "Theory of Machines."

It must also be remembered that the dockyard candidate has an enormous advantage over the extra-dockyard candidate in that he has available copies of old papers which are unobtainable to the latter; anyone who has tried will acknowledge the great difference in studying a subject as defined by a syllabus and as defined by old examination papers. I would suggest that copies of all old papers be made generally available.

I am, Sir, Yours faithfully,
GRAHAM ASHWORTH.

51, Victoria-street, London, December 2, 1924.

P.S.—For your information I would add that I obtained a Whitworth Senior Scholarship in 1923 and First Class Honours in B.Sc.(Eng.) London in 1924.

To the Editor of Engineering.

SIR,—Mr. Ottewell's letter and the leading article in your current issue must have been read with great interest. An apprentice or engineering student in any large industrial engineering establishment is there first and foremost in order to acquire practical experience.

A certain number of the larger concerns have established classes and lectures during working hours, and the object of these lectures is to improve the theoretical and general knowledge of the student in that particular branch of the industry for which he is being trained. Apart from the time occupied by these lectures, which is but a very few hours per week, the apprentice is actually and truly occupied in practical work, all studying having to be done outside working hours.

In the Royal Establishments the whole curriculum results in practically the weeding out of the apprentices, with the passing of the Royal and Whitworth Scholarships as an ultimate end. From their entry into the establishment the apprentice is coached and works with this end in view; the periods of coaching during working hours is very much greater than that obtaining in industrial works, and, in spite of what might be said to the contrary, it is well known that cramming for examinations is given preference over practical training, and opportunities to further this end are not lacking.

In short, industrial establishments aim at turning out trained, practical engineers and mechanics. The object of the apprenticeship system in the Royal Establishments is to enable their ratings to win Whitworth Scholarships.

Sir Joseph Whitworth instituted these scholarships for the practical apprentice: let the examination be framed so that practical knowledge and skill have a value equal to that given to theoretical training and the results would be very different.

I am, Sir, Yours faithfully,
W. J. THOMAS.

57A, Stanley Gardens, Belsize Park, Hampstead, N.W.3.
December 1, 1924.

SIDE PLANING MACHINE.

SIDE planing machines fall into two categories, namely, one class in which the work is carried on a moving table of the usual planing machine pattern, and a second in which the work is fixed and the cutting tool is traversed over it. Messrs. Geo. Richards and Co., Limited, of Broadheath, Manchester, have for many years specialised in the latter type, and in Figs. 1 and 2, on p. 772, we illustrate one of their latest machines of this class. The chief change introduced in this machine is in the form of drive for the tool slide carriage. This drive is now effected by means of endless chains, instead of by a long screw extending from end to end of the bed.

The machine is belt driven, by means of two fast and loose pulleys in a frame at the left end of the bed. These are of different sizes, and open and crossed belts from the countershaft give a cutting stroke at one speed and a quick return. The cutting stroke is usually arranged at 40 ft. per minute, and the return at 150 ft. per minute, but cutting at 60 ft. per minute can be provided for if necessary. The pulleys drive a short shaft on which is a worm gearing with a large worm wheel on a shaft extending in a direction across the body of the machine. The thrust of the multi-threaded worm is taken by ball bearings. On the worm wheel shaft, inside the body, are two chain sprockets, which drive endless chains extending the length of the inside of the body, there being at the far end idlers over which they are carried. There are two parallel chains set half a pitch out of phase, in order to ensure evenness of drive over the sprockets. The requisite tension is kept on them by means of a stretcher fitted with right- and left-handed screws. The worm and chains run in oil baths. The tool slide carriage is coupled to the two chains by a swivel shackle to equalise the strain. The carriage is of considerable length and is fitted with an arm projecting over the front of the bed, and carrying two tool boxes on elevating slides. The tool boxes swivel and can be set for angular or undercutting on either side. The traverse feed of the boxes on the arm is by pawl and ratchet wheel, the pawl having an adjustable stroke obtained by the slotted crank method.

At the back of the machine is a shipper bar from which the feed motion is derived, and which also operates the reversing gear. The left end of the bar is finished with a number of grooves forming a circular rack. These teeth gear with a sector on a double-armed lever, at the opposite end of which another toothed sector meshes with teeth on a rack sliding in brackets. This operates the belt-shifting levers, as will be clear from Fig. 2. The shipper bar is fitted with adjustable stops so that the machine can be set to reverse at any desired stroke in the ordinary way.

The main part of the length of the shipper bar is rectangular, and the adjustable stop referred to above is fitted with arms, which, as the carriage approaches, come in contact with a scroll cam on the carriage. The profile of the cam causes the shipper bar to rotate through 180 degrees, and this action causes a bevel on the carriage and sliding with it longitudinally on the shaft, also to revolve. The drive from this bevel is transmitted by a corresponding mitre gear to the slotted feed crank referred to above.

The machine has two tables on saddles working over slides on the front of the bed. In the smaller machines these are worked into position with a bar, engaging with rack holes in the bed front. In machines of large size the table saddles have pinions operated by ratchet and engaging with a cut rack. The tables are independent and have screw elevating gear. They are finished with tee-slots on the top and sides, but can be removed and work bolted directly against the saddles. An upper table can be supplied for fixing to the two work tables, to take long and slender jobs.

The type of planer possesses many advantages for heavy work. The weight of the work is immaterial, since it has not to be moved, as is the case when mounted on a table in the ordinary way. The power to be supplied is, therefore, always the same and depends merely upon the cut and weight of the carriage, &c. Not only is this a material point for the cutting stroke, but the saving is greatly enhanced as a result of the great reduction of inertia forces to be contended with in reversing. These characteristics are still further emphasised in Messrs. Geo. Richard's chain-driven model, in which the long screwed driving shaft is replaced by the chain, and the only high-speed parts are the pulleys and worm shaft. The chain is slow moving. The chain drive also replaces the sliding contact of the driving screw and nut by plain rolling contact, thus again reducing the losses. This type of machine possesses the further advantage of economy in space as the work is stationary during machining operations. The machine is built in sizes up to 30 ft., or more, long and for machining up to 5 ft. in width. When desired it can be built for cutting in both directions. With a pit in front of the machine, there is practically no limit to the size of the job on which work can be done, provided the surface can be brought under the tool. The open front and the fact that the work is stationary, make it possible to work on most awkward pieces. These points, however, are now so well known as to need little elaboration, though it is doubtful if the utility of this type of machine is appreciated as fully as it might be at the present time.

PROJECTED DEVELOPMENTS AT CHERBOURG.—It is announced in *The Times* that negotiations are in progress for the acquisition by the United States Lines of a port at Cherbourg to be reserved exclusively for American vessels. The docking facilities at Southampton are considered inadequate, and this has led to the project of making Cherbourg the European terminus for the United States Lines, who are prepared to expend 25 million francs on the necessary works. The French authorities have also prepared schemes for the improvement of this port, and in particular have got out plans for the reconstruction of the existing awkward and inadequate dock station.

THE FLETTNER ROTOR SHIP.—It is interesting to note in respect to the Flettner rotor ship that, with a constant speed of rotation, the theoretical propulsive power increases as the square of the rotor diameter, whilst a large sail is but slightly more efficient than a small one, the propulsive power of a sail being approximately proportional to its area. Hence, with a high speed of rotation, the propulsive effect of a Flettner tower may be several times that of a sail having an area equal to the longitudinal section of the tower. On the other hand, the power required to rotate the tower increases nearly as the fourth power of the diameter, so that with very large diameters most of the work of propulsion would be provided by the motor and not derived from the wind.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—There is a fairly good business passing in Cleveland pig-iron, supply of which is no more than sufficient for current needs, and as stocks are oversold, shortage would speedily follow further improvement in demand unless production was increased without delay. Values are steadily firm with makers by no means pressing sales. No. 1 is 87*s.*; No. 3 g.m.b., 82*s.*; No. 4 foundry, 81*s.*; and No. 4 forge, 80*s.*

Hematite.—Continued rather substantial withdrawals from East Coast hematite stocks have strengthened the hands of producers. Supplies are still plentiful, but the improving statistical position encourages hope that the situation will become such as to justify the re-kindling of one or two idle furnaces in the near future. No. 1 is selling at 89*s.* 6*d.* and Nos. 1, 2 and 3 command up to 89*s.*

Blastfurnace Coke.—Durham blastfurnace coke is rather more sought after but it is plentiful, and no difficulty is experienced in purchasing good average qualities at 25*s.* delivered here.

Manufactured Iron and Steel.—Better accounts are given of most manufactured iron and steel branches, and values, though not quotably advanced, tend towards firmness. Demand for shipbuilding requisites shows some improvement, a few sales of railway material are reported, constructional steel is more readily disposed of, and further heavy contracts for galvanised corrugated sheets have been made. The following are among the principal market quotations:—Common iron bars, 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy sections of steel rails, 9*l.*; fish plates, 12*l.* 10*s.*; and galvanised corrugated sheets (24-in. gauge, in bundles), 18*l.*

Tees Iron and Steel Shipments.—The total shipments of iron and steel from the Tees last month amounted to 92,524 tons, as compared with 105,499 tons in October and 75,122 tons in September. November clearances comprised 34,980 tons of pig iron; 7,144 tons of manufactured iron; 50,400 tons of steel. Of the pig-iron loaded 16,448 tons went to foreign ports, and 18,532 tons went coastwise. Of the manufactured iron despatched 3,767 tons went to foreign ports and 3,377 tons went coastwise; and of the steel cleared 40,157 tons went to foreign ports and 10,243 tons went coastwise. Scotland was the heaviest customer for pig iron, taking 14,432 tons; whilst Germany imported 4,390 tons; Wales, 3,800 tons; Denmark, 3,228 tons; Italy, 2,620 tons; Belgium, 1,388 tons; France, 1,255 tons; and Norway, 1,250 tons. Natal was the largest purchaser of manufactured iron receiving 2,407 tons. Principal importers of steel were: India, 9,770 tons; Portuguese West Africa, 5,200 tons; Argentine Republic, 4,893 tons; Burmah, 2,110 tons; Victoria, 2,069 tons; Holland, 2,036 tons; and Tanganyika, Japan, West Australia, Natal and New South Wales each over 1,000 tons.

Imports of Iron and Steel to the Tees.—The Tees Commissioners' monthly returns issued this week give the imports of iron and steel to the River Tees from Holland, Belgium, France, Norway, Sweden, Germany, India and coastwise for October and November together with the figures for the same months last year, and for the corresponding pre-war period of 1913. For the two months just ended 3,901 tons of pig iron were imported as against 2,556 tons a year ago, and 268 tons in 1913. Crude sheet bars, billets, blooms and slabs unshipped to the end of November last reached 20,249 tons, as against 13,503 tons a year ago, and 10,986 tons in 1913. Arrivals of plates, bars, angles, rails and sheets in the last two months totalled 3,678 tons, as against 1,224 tons a year ago, and 3,601 tons in 1913.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—No change of any importance can be reported in the Scottish steel trade this week and movement continues within narrow limits. Specifications both for plates and sections are extremely scarce, and the running of the mills is not satisfactory. The position in the black sheet trade is, if anything, rather better. A healthy demand exists for both light and galvanised qualities, and quite a number of orders have been booked for spring delivery. The heavier gauges are also the turn better, but expansion is very slow. Prices all round keep steady and are as follow:—Boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; and sheets, $\frac{1}{16}$ to $\frac{1}{8}$ in., 12*l.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—In the West of Scotland malleable-iron trade the conditions have not varied over the week, and works are poorly employed. Consumers are sending out specifications very sparingly, and no distance ahead can be seen. The price of "Crown" bars is unchanged at 12*l.* per ton delivered Glasgow stations. The re-rolled steel branch of the trade is also very quiet at present.

Scottish Pig-Iron Trade.—A quiet but hopeful tone continues to prevail in the Scottish pig-iron trade, and, although business is not a great deal better, signs are not wanting of steady improvement before long. Local buying in hematite is poor, but in foundry grades there is more doing. General inquiries for export lots are much better, and in this connection the amount fixed up is not as heavy as producers would like, but some of the business is still to settle and may come through all right in due course. The following are the market quotations:—Hematite, 4*l.* 15*s.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 15*s.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, November 29, amounted to 728 tons. Of that total 687 tons went overseas and 41 tons coastwise. For the corresponding week of last year the figures were 1,942 tons overseas and 80 tons coastwise, making a total shipment of 2,022 tons.

Shipbuilding.—The shipbuilding returns for the past month show that active conditions have been ruling in the yards during recent months and that the workmen continue to do well. The total Scottish output was 20 vessels of 57,956 tons, and all of that was from Clyde yards except four vessels of 845 tons, which were launched in the Dee and Moray Firth area. The Clyde figures are over the average and make the total for the year to date 199 vessels of 516,892 tons, which is the highest output for the corresponding period since the year 1920. For the same eleven months of last year the total was only 99 vessels of 172,275 tons, or a third of this year's figures, which are, however, about 112,000 tons under the record year, 1913, when 628,816 tons were put into the water. Quite a number of new contracts have been reported during the month, but many more are needed before active conditions can be general in the yards.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Though leading steelmakers and engineering masters are still of the opinion that a definite improvement may be looked for early in the new year, the current position reveals several weak spots, and important sections are finding difficulty in maintaining active conditions. The amount of business passing in billets and other descriptions of semi-finished materials leaves much to be desired. The effect of Continental underquoting continues to react severely against new bookings, despite the fact that prices on the average are 1*l.* per ton below those quoted a year ago. Not only at steel furnaces but also at rolling mills, forges, and foundries is the heavy burden of local rates and national taxes operating with damaging results. One of the leading rolling mill plants, which recently suspended production pending a rearrangement of its wages basis, is still idle. The Chief Insurance Officer has referred to a local Court of Referees the claim made by 600 employees for unemployment benefit. Makers of automobile steel are fairly well booked forward, and prospects are good. More business is in hand on British account for axles, tyres and wheels, though the majority of the contracts received from private owners of wagons are nearing completion. Pit-head gear is an improving line, and good business is being done in electrical apparatus, mining excavating tools, and builders' ironwork and fittings. Mr. J. Joyce Brodrick, Commercial Counsellor to the British Embassy at Washington, who during the past week has visited Sheffield, stressed the advantages to be derived from American trade by the appointment of agents in each case to act on behalf of a number of local firms. He points out that American works at frequent intervals get behind with their orders, and find it necessary to fill requirements from overseas producers, and at these intervals Sheffield firms with agents on the spot might do considerable business. Developments in corrosion-resisting steels are being carefully watched, particularly by engineers. Dr. W. H. Hatfield, of the Brown-Firth Laboratories, addressing the Yorkshire Branch of the Institution of Mechanical Engineers at Sheffield, pointed out that the metallurgical world had by experiment and hard work produced and placed upon a permanent technical foundation a number of steels which could be used under satisfactory resistant conditions.

South Yorkshire Coal Trade.—The advent of somewhat more active trading conditions is reflected in a substantially increased output at the Yorkshire pits. Export buyers of best steams are taking a keener interest in the market, though the demand continues below the recent average, while home purchases show a slight expansion. The offer of special lots of cobbles and nuts and of surplus tonnages of fine slacks reacts adversely against official quotations. Business in house coal is flowing a little more freely, though the gross demand is much below that usually experienced at this time of the year. The coke position is mainly unchanged, with gas coke in rather better request. Quotations:—Best branch handpicked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 20*s.* 6*d.* to 23*s.*; Derbyshire hards, 20*s.* 6*d.* to 22*s.* 6*d.*; rough slacks, 9*s.* 6*d.* to 12*s.*; nutty slacks, 9*s.* to 11*s.*; smalls, 5*s.* to 7*s.* 6*d.*

THE BRITISH ENGINEERING STANDARDS ASSOCIATION.—The Main Committee of the British Engineering Standards Association have recently authorised the Secretary, Mr. le Maistre, to accept the invitation of the German Standards Committee (the N.D.I.) to be present at their annual meeting on December 13th. He is also going to Prague to give an address on Industrial Standardisation before the recently-formed Czecho-Slovakian Standards Committee.

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—To-night, at 6 p.m., at Storey's-gate, S.W.1. Extra General Meeting. "The Effects of Low and High Temperatures on Materials," by Professor F. C. Lea, D.Sc. "The Elastic Limit in Tension, Its Influence on the Breakdown by Fatigue," by Mr. J. M. Lessels, B.Sc.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night at 7.30 p.m., at 39, Victoria-street, S.W.1. Lecturette, "Metal Cutting under Water by the Oxy-Acetylene Blow Pipe," by Mr. J. P. Polland. Friday, December 12, at 7.30 p.m. Ordinary Meeting. "Fluid Transmission Gears," by Mr. H. G. Bouly.

THE INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Saturday, December 6, at 4 p.m., at the College of Technology, Sackville-street, Manchester. "'Spun' Iron Pipes," by Mr. R. A. Miles.

THE INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Monday, December 8, at 7.30 p.m., at the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Ships' Propellers," by Mr. S. E. Flack.

THE ROYAL SOCIETY OF ARTS.—Monday, December 8, at 8 p.m., at John-street, Adelphi, W.C.2. Cantor Lecture. "Modern Colour Problems" (Lecture III), by Mr. Louis C. Martin, D.I.C., A.R.C.S., D.Sc. Wednesday, December 10, at 5 p.m. Ordinary Meeting. "Colombia as a Field for Development," by Mr. Norman Thomson. Thursday, December 11, at 8 p.m. Inaugural Address. "Radio Communications," by Senatore Guglielmo Marconi, G.C.V.O., LL.D., D.Sc. (Postponed from November 5.)

THE INSTITUTION OF MECHANICAL ENGINEERS: SOUTH WALES BRANCH.—Tuesday, December 9, at 6 p.m., at the Chamber of Commerce, Swansea. Lecture. "Economics of Engineering," by Mr. Daniel Adamson.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Tuesday, December 9, at 7 p.m., at the Royal Technical College, George-street, Glasgow. "An Electric Harmonic Analyser," by Messrs. J. D. Cockcroft, R. T. Coe, J. A. Tyacke, and Professor Miles Walker.

THE INSTITUTION OF CIVIL ENGINEERS.—Wednesday, December 10, at 7 p.m., at Great George-street, S.W.1. Informal Meeting. Subject for discussion, "Suitable Fendering for Tidal Berths," to be introduced by Mr. Ernest Latham, M.Inst.C.E. Thursday, December 11, at 6 p.m. Extra Meeting. Joint Meeting with the following bodies: The Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects, the Institute of Marine Engineers, the North East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers Association, the British Engineers' Association, which are co-operating in the work of the Special Committee on Tabulating the Results of Heat-Engine and Boiler Trials. Subject submitted for discussion, "Standards of Comparison in Connection with the Thermal Efficiency of Steam Engines," introduced by Captain H. Riall Sankey, C.B.

THE OPTICAL SOCIETY.—Thursday, December 11, at 7.30 p.m., at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, S.W.7. "The Transformation of Trichromatic Mixture Data," by Mr. J. Guild, A.R.C.Sc. "An Equipment for Visual Spectrophotometry," by Mr. J. Guild, A.R.C.Sc. "A Simple Micro-photometer," by Mr. L. C. Martin, D.Sc. The following apparatus will be exhibited and described:—(*a*) A Telescope Support. (*b*) A Prism Holder for Vertical Projection, by C. V. Boys, F.R.S. Slow Speed Precision Training Gear Governed from a Distance, by Dr. P. P. Schilovsky.

THE INSTITUTE OF METALS: LONDON LOCAL SECTION.—Thursday, December 11, at 7.30 p.m., at 85-88, The Minories, Tower-hill, E.1. Joint Meeting with the Institute of Marine Engineers. "Present Problems and Developments in Engineering Bronze Foundry Practice," by Mr. F. W. Rowe, B.Sc.

THE INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Friday, December 12, at 7.15 p.m., at the University College, Singleton Park. Discussion on "The Design of Furnaces for Annealing and Heat Treatment," to be opened by Mr. T. Hill.

THE WEST BROMWICH ENGINEERING SOCIETY.—Friday, December 12, at 7.30 p.m., at the Technical School, West Bromwich. "Lighthouse Engineering; Marine Fog Signals," by Mr. W. F. A. Richey.

THE NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, December 12, at 7.30 p.m., at Bolbec Hall, Newcastle-upon-Tyne. "Fuel Oil for Marine Internal-Combustion and Steam Engines," by Mr. Sterry B. Freeman.

THE MIDLAND INSTITUTE OF MINING ENGINEERS.—Saturday, December 13, at 2.15 p.m., at the Danum Hotel, Doncaster. "Mines (Working Facilities and Support) Act, Part I, 1923," by Mr. J. H. Cockburn. Discussion on "The Collieries of the First Danube Steam Navigation Company (D.D.S.G.) Nr Pécs (Funfkirchen), Hungary," by Dr. J. Herczegh. "The Utilisation of Waste Heat and Surplus Gas from Coke Ovens," by Mr. I. C. F. Statham, B.Eng.

THE HULL ASSOCIATION OF ENGINEERS.—Saturday, December 13, at 7.15 p.m., at the Municipal Technical College, Park-street, Hull. Lecture, "Autogenous Welding," by Mr. J. Key, Junr.

SIDE PLANING MACHINE.

CONSTRUCTED BY MESSRS. GEO. RICHARDS AND CO., LIMITED, ENGINEERS, BROADHEATH, MANCHESTER.

(*For Description, see Page* 770.)

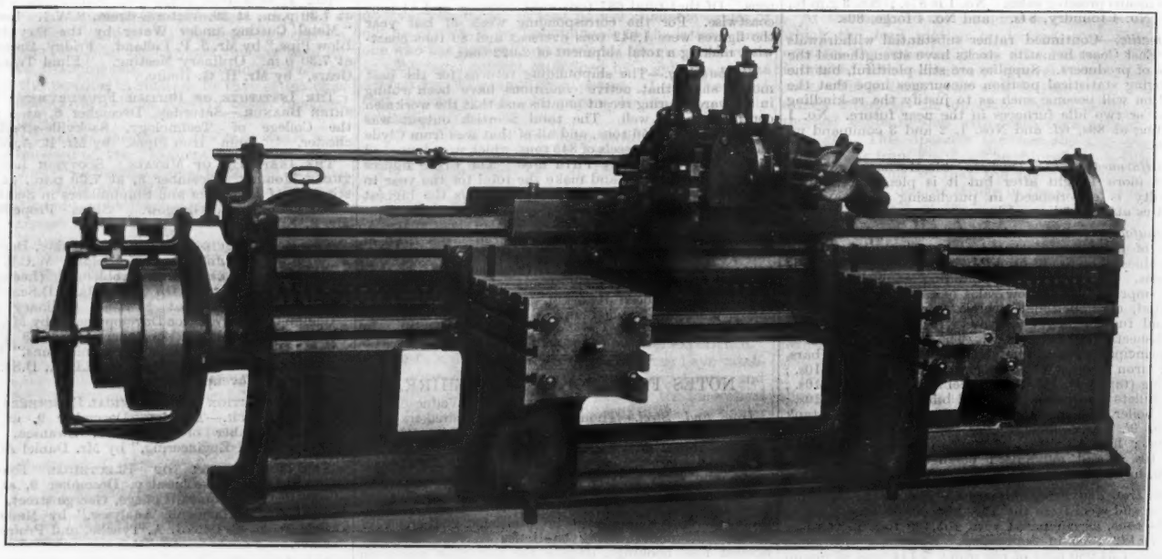


Fig. 1.

NOTES FROM THE SOUTH-WEST.

Cardiff, Wednesday.

The Coal Trade.—The joint audit for the South Wales coalfield for October has just been issued, and shows that for the fifth month in succession a heavy loss has been sustained by the Welsh coal trade. It certifies that on the basis of the national agreement the wages payable in December should be 15·55 per cent. above the 1915 standard as compared with 17·6 per cent. in September. The October certified rate is the lowest under the present agreement, but the general wage rate payable by the coal owners is the minimum of 42·22 per cent., or 26·67 per cent. above the certified rate, the difference being met by the colliery owners, who are once again compelled to surrender not only their share of the surplus profit but also their standard profit and, in addition, draw on reserves or obtain loans from bankers. In October there was a loss of 107,327*l.* on the quantity of coal raised, representing a loss of 6·47*d.* per ton, compared with a loss of 158,552*l.* or 10·07*d.* per ton in September; while in the five months ending October there has been a total loss of 737,170*l.*, or at the rate of 1,770,000*l.* per annum, representing a loss of 9·25*d.* per ton in the five months. In October there was, however, an increase in output which resulted in a reduction in the cost of production. Wages costs, for instance, were reduced by 4½*d.* per ton and other costs by 2*d.* per ton, making a total reduction of 6½*d.* per ton as compared with September. Average pithead prices, however, were also reduced by 2½*d.* per ton, and it may be of interest to mention that the cost of production in the South Wales coalfield was practically 8*s.* per ton higher than in 1913, of which wages accounted for 5*s.* 6*d.*, apart from an additional 8*d.* per ton due to the extra benefits now received by the miners under the health and unemployment insurance, welfare, and other schemes. In the meantime, however, the coal market has developed a much stronger tone, and business is on an expanding scale, with available supplies more difficult to secure than has been the case for some weeks past. Small coals in particular are in short supply, and the best bunker sorts rule up to 17*s.*, with ordinaries around 14*s.* 6*d.*, but if taken in conjunction with large are obtainable at about 6*d.* less. Best Admiralty large coal is steady at 27*s.* 6*d.*, with seconds from 25*s.* to 27*s.* Monmouthshires are irregular at 23*s.* 6*d.* to 24*s.* 6*d.* Duff coals are strong and scarce. Bituminous sorts rule up to 19*s.* 6*d.*, with dry duff round 16*s.* 6*d.* It is stated that French State Railways have placed contracts with various exporters for supplies over the first three or six months of next year, while news is also awaited of the decision of the Egyptian State Railways in regard to their inquiry for c.i.f. tenders for 200,000 metrical tons of large coal over the first five months of next year.

Iron and Steel Trades.—Exports of iron and steel goods from South Wales last week amounted to 15,628 tons, against 18,077 tons in the previous week. Shipments of tinplates and terneplates amounted to 9,111 tons, against 9,600 tons; blackplates and sheets to 2,267 tons, against 6,799 tons; galvanised sheets to 3,055 tons, against 1,060 tons; and other iron and steel goods to 1,195 tons, against 618 tons.

Fig. 2.

Personal.—Messrs. Alfred Herbert, Limited, of Coventry, who for many years have acted in conjunction with another company as joint selling agents for Norton grinding wheels, will in future act as sole selling agents for all Norton wheels in Great Britain and Ireland. Stocks will be carried by Messrs. Herbert at Coventry, London, Birmingham, Bristol, Manchester, Newcastle-on-Tyne, and Glasgow.

STRAUSS BASCULE BRIDGE OVER THE BANN RIVER AT COLERAINE, IRELAND.

CONSTRUCTED BY MESSRS. SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, CONTRACTORS, WESTMINSTER.

(*For Description, see Page* 758.)

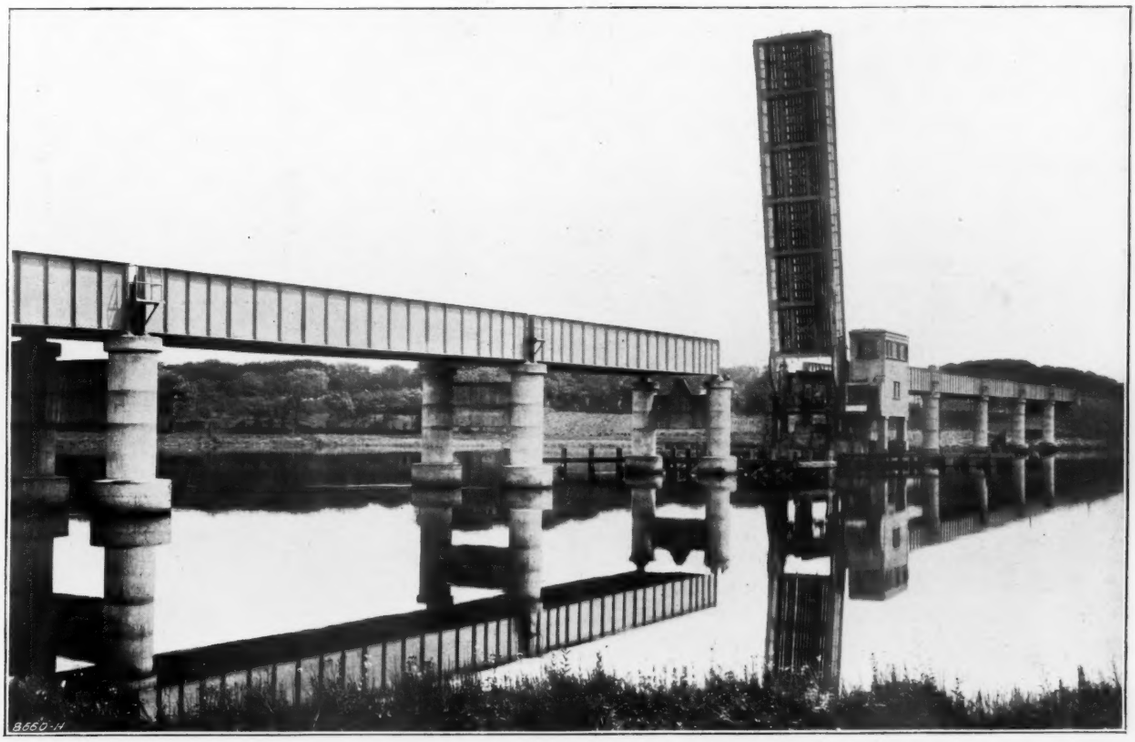


FIG. 2. VIEW OF THE BRIDGE FROM THE LONDONDERRY SIDE.

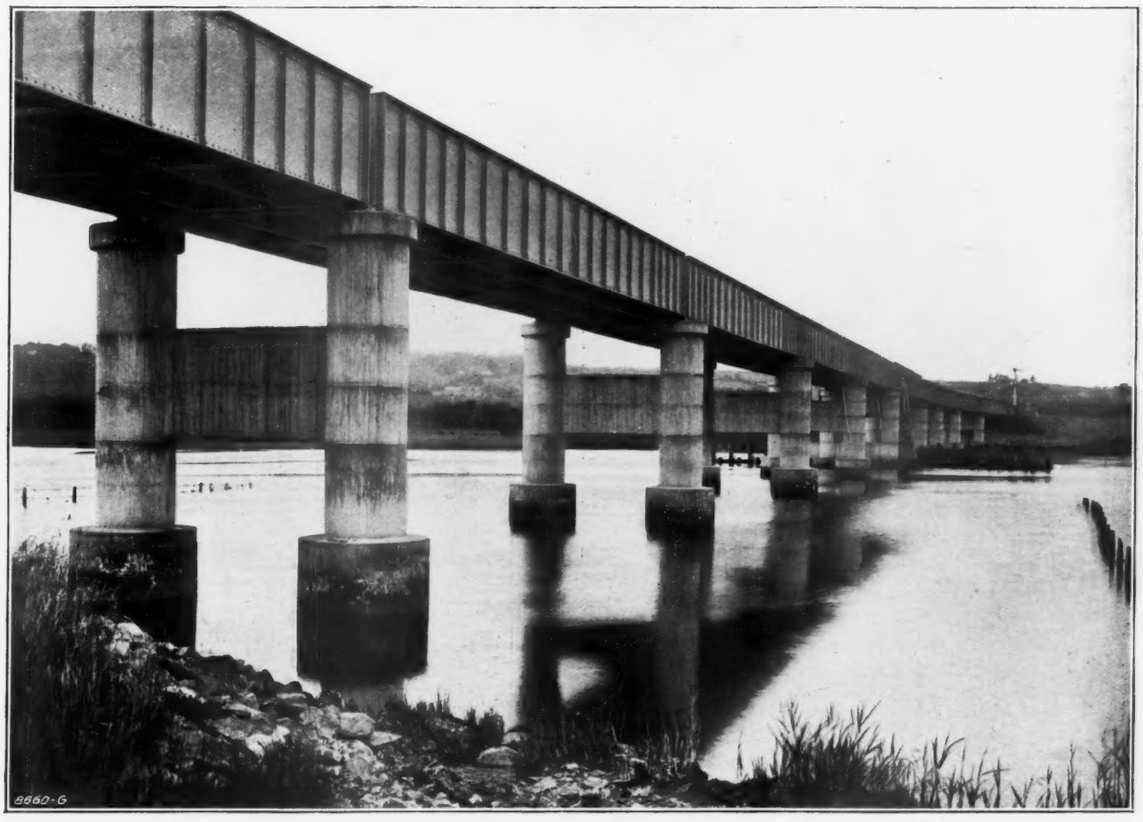


FIG. 3. VIEW OF BRIDGE TAKEN FROM THE COLERAINE SIDE.

(*To face page* 758.)

STRAUSS BASCULE BRIDGE OVER THE BANN RIVER AT COLERAINE, IRELAND.

CONSTRUCTED BY MESSRS. SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, CONTRACTORS, WESTMINSTER.

(For Description, see Page 758.)

Fig. 4.

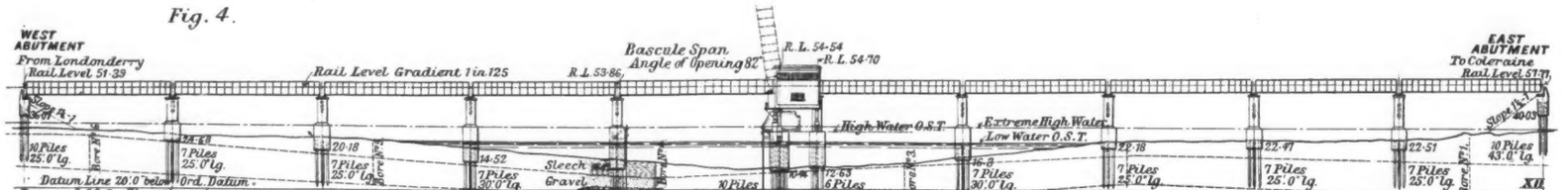


Fig. 5.

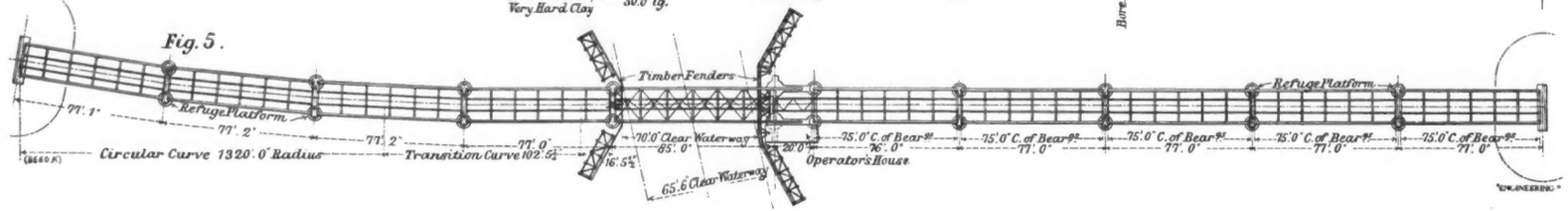


Fig. 6. ELEVATION ON B.B.

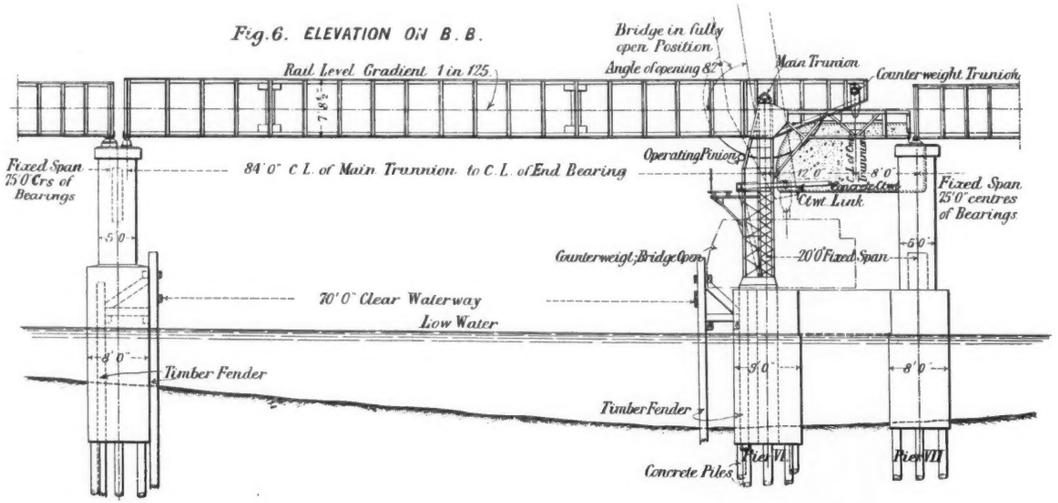


Fig. 8. SECTION ON LINE A.A.

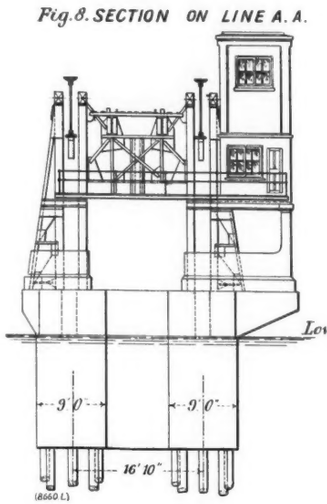


Fig. 9. ELEVATION ON C.C.

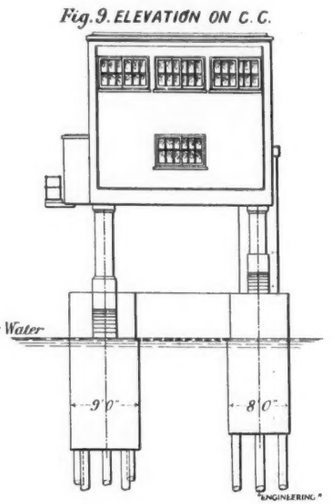


Fig. 7.

Fig. 10. CROSS SECTION SHOWING TIMBER DECK

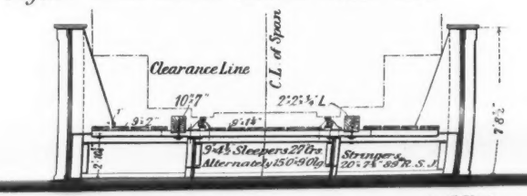


Fig. 11.

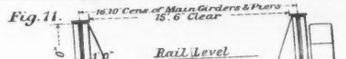
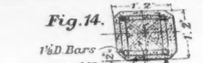
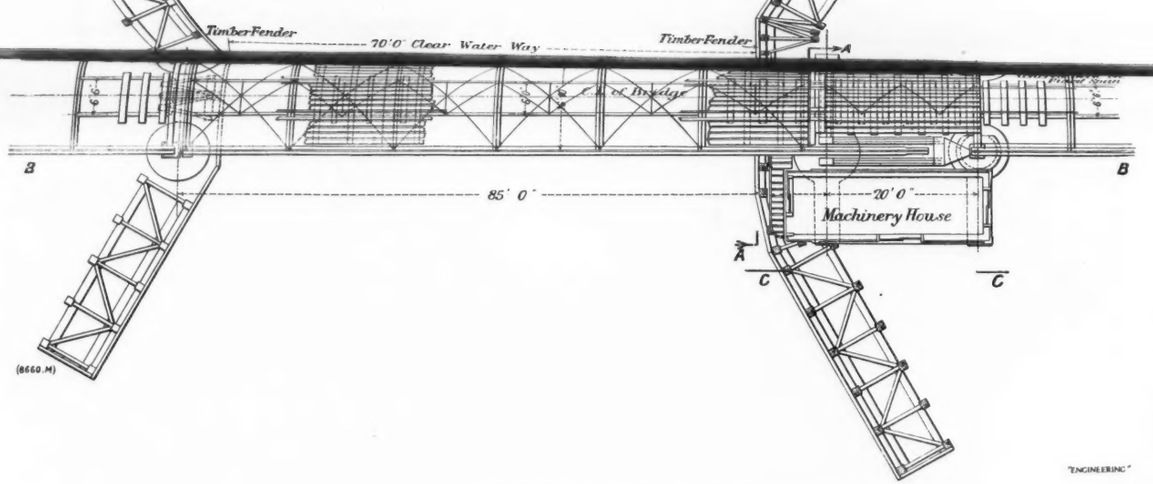


Fig. 14.




Timber Fender
70'0" Clear Water Way
Timber Fender
C.L. of Bridge
85' 0"
20' 0"
Machinery House
A
B
C
(8660.M)

9"x 4½" Sleepers 2'0" c/c
Alternately 1'0" & 0'6"
Stringers
20"x 7½" R.S.J.

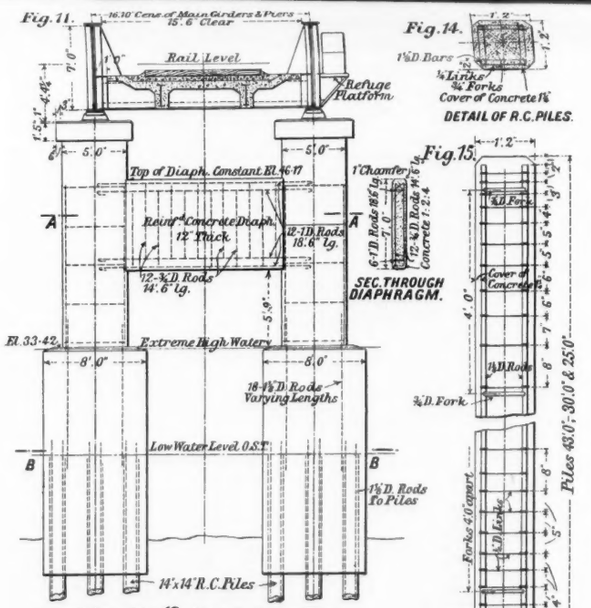


Fig. 11.
16.10' Cens of Main Girders & Piers
15'.6 Clear
Rail Level
Refuge Platform
Top of Diaph. Constant El. 16·17
Round Concrete Diaph. 12" Thick.
12-1" D. Rods 18.6" Lg.
12-¾" D. Rods 14'.6" Lg.
SEC. THROUGH DIAPHRAGM.
El. 33·42
Extreme High Water
18-1⅛" D. Rods Varying Lengths
Low Water Level. O.S.T.
1½" D. Rods To Piles
14"x14" R.C. Piles
Fig. 12. PLAN A.A.
16'. 10"
1" D. Rods
Fig. 13. PLAN B.B.
Fig. 14.
1" D. Bars
⅛ Links ¾" Forks
Cover of Concrete 1½"
DETAIL OF R.C. PILES.
Fig. 15.
¾" D. Fork
Cover of Concrete
1" D. Rods
¾" D. Fork
Forks 4'0" apart
1" D. Links
Pile Shoe 56 Lbs.
Piles 43'0", 30'0" & 25'0"
"ENGINEERING"

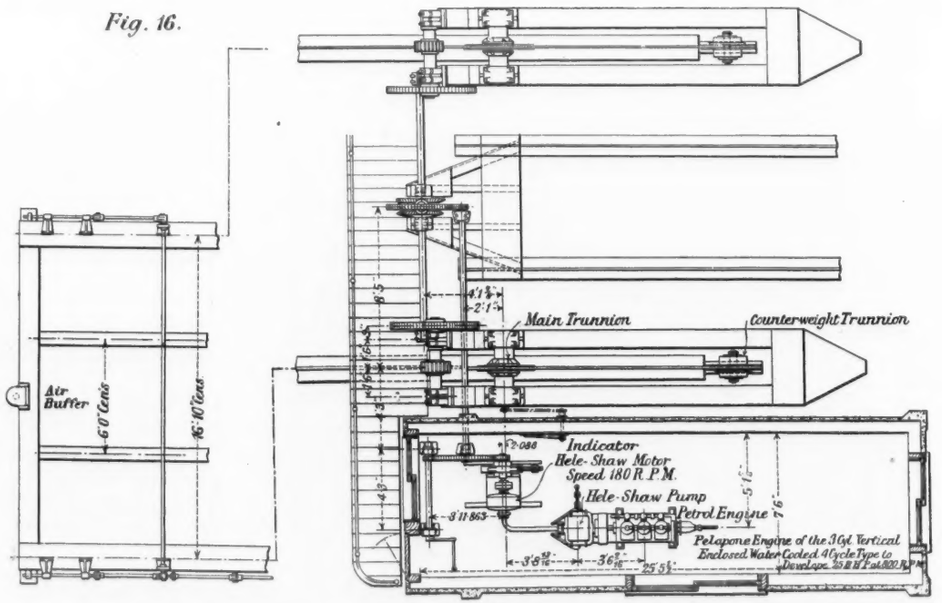


Fig. 16.
Air Buffer
6'0" Cens
16'·10" Cens
Main Trunnion
Counterweight Trunnion
Indicator
Hele-Shaw Motor
Speed 180 R.P.M.
Hele-Shaw Pump
Petrol Engine
Pelapone Engine of the 3 Cyl. Vertical Enclosed Water-Cooled 4 Cycle Type to develope 55 B.H.P. at 800 R.P.M.

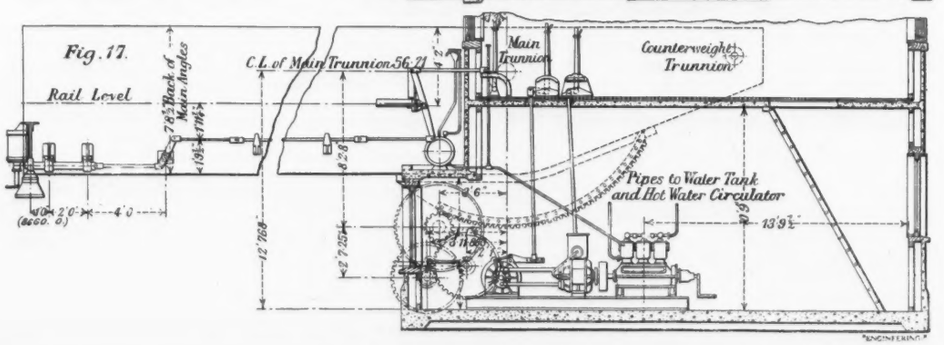


Fig. 17.
Rail Level
C.L. of Main Trunnion 56'21
Main Trunnion
Counterweight Trunnion
Pipes to Water Tank and Hot Water Circulator
(8660. D)
"ENGINEERING"

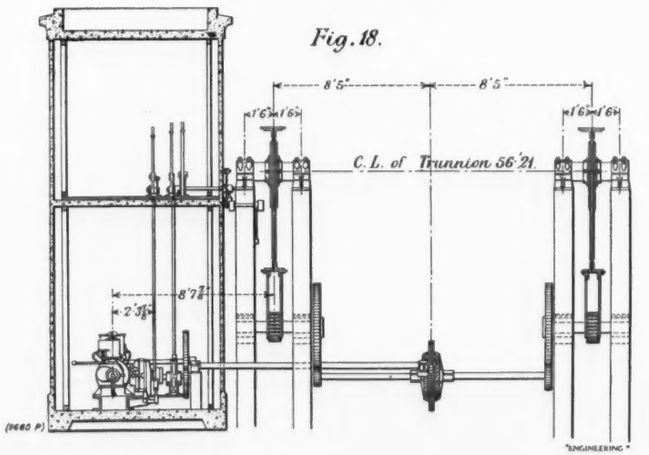


Fig. 18.
8'5"
8'5"
C.L. of Trunnion 56'21
(8660.P)
"ENGINEERING"

STRAUSS BASCULE BRIDGE OVER THE BANN RIVER AT COLERAINE, IRELAND.

CONSTRUCTED BY MESSRS. SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, CONTRACTORS, WESTMINSTER.

(*For Description, see Page* 758.)

FIG. 19. DERRICK CAR USED FOR PLACING THE GIRDERS.

FIG. 20. THE LAST FIXED GIRDER BEING PLACED IN POSITION.

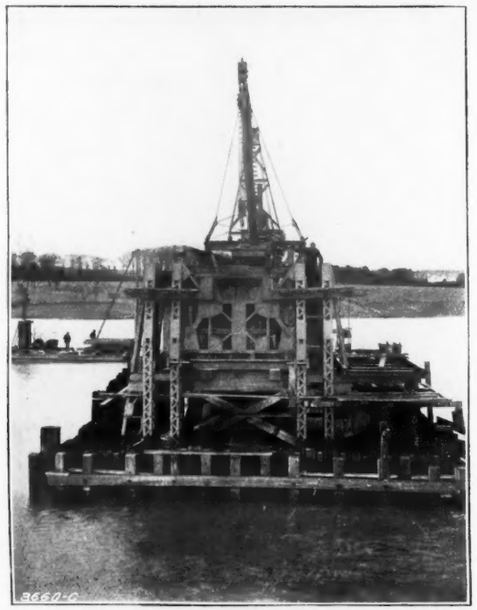


FIG. 21. BASCULE TRUNNION POSTS BEING ERECTED.

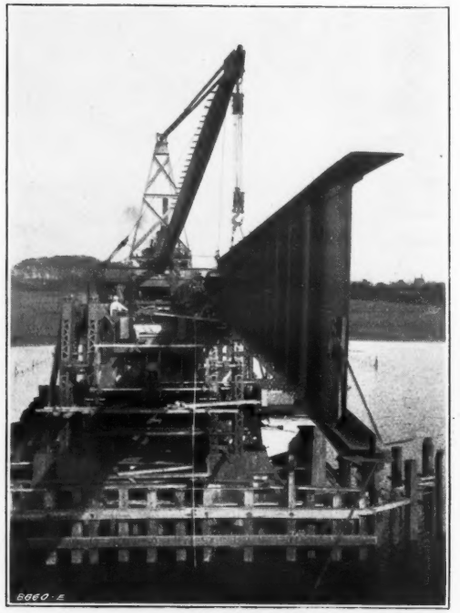


FIG. 22. PART OF THE BASCULE GIRDER BEING PLACED IN POSITION.

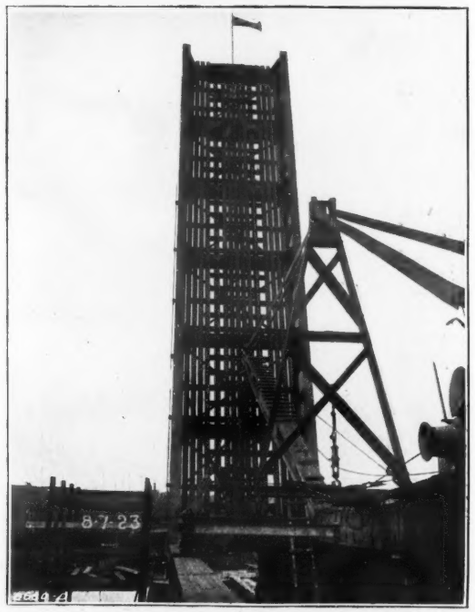


FIG. 23. THE BASCULE SPAN RAISED AFTER COMPLETION.

(*To face page* 759.)

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8598 GERRARD.

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance :—

For the United Kingdom	£3	5	0
For Canada—			
Thin paper copies	£2	18	6
Thick paper copies	£3	3	0
For all other places abroad—			
Thin paper copies	£3	3	0
Thick paper copies	£3	7	6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

All accounts are payable to "ENGINEERING," LTD. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia Melville and Mullen, Melbourne, Victoria.

BELGIUM, Brussels: E. F. Satchell, 86, Rue du Tabellion.

CANADA, Toronto, Ont.: Wm. Dawson and Sons, Limited, 87, Queen Street East.

EDINBURGH: John Menzies and Co, Limited, Rose-street.

FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Advertisements, Office de Publications Commerciales 167, Rue Montmartre, Paris (2e).

GERMANY: Hermann H. Fromm, Lützowstrasse 84, Berlin, W. 35. A Twietmeyer, Leipzig.

GLASGOW: William Love, 221, Argyle-street. John Menzies and Co., Limited, West Nile-street.

INDIA, Calcutta: Thacker, Spink and Co., Bombay; Thacker and Co., Limited.

ITALY: U. Hoepli, Milan. Anonima Libraria Italiana, Torino, and any post office.

LIVERPOOL: Mrs. Taylor, Landing Stages.

MANCHESTER: John Heywood, 143, Deansgate.

NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.

NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.

ROTTERDAM: H. A. Kramer and Son, Limited.

SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and various branches and bookstalls throughout South Africa. Wm. Dawson and Sons (South Africa), Limited, 29, Long-street, Capetown.

TASMANIA: Gordon & Gotch Prop'ty, Ltd., Launceston: Hobart.

UNITED STATES: For Subscription, New York: W. H. Wiley, 440, Fourth Avenue. For Advertisements: J. S. Allan, 30, Church Street, New York.

CONTENTS.

	PAGE
Reparations and the British Engineering Industry	757
Strauss Bascule Bridge over the Bann River, Ireland (*Illus.*)	758
Geared Turbines of the English Electric Co. (*Ill.*)	760
An Extension of the Middle Third Theory (*Illus.*)	763
The A.1. Electric Welders (*Illus.*)	764
United States Production and Consumption of Oil	765
The Cardiff Engineering Exhibition (*Illus.*)	766
Letters to the Editor.—Michell Journal Bearings applied to Cold Rolls (*Illus.*). The Extent of Cavitation in U.S. Scouts and Destroyers. "The Determination of Stresses by Optical Methods." The Remuneration of Technical Men. The Whitworth Scholarships	769
Side Planing Machine (*Illus.*)	770
Notes from South Yorkshire	771
Notes from Cleveland and the Northern Counties	771
Notes from the North	771
Notices of Meetings	771
Notes from the South-West	772
Factories and Workshops Accidents	773
Coastal Traffic	774
The Deterioration of Structures in Sea Water	774
The City and South London Railway	775
Notes	776
Engineering Schemes in Parliament	776
Somerset Oil Shares	777
Labour Notes	778
Notes on New Books	779
French Naval Planes	780
Diagrams of Three Months' Fluctuations in the Prices of Metals	780
Oil-Engine Driven Electric Shunting Locomotive (*Illus.*)	781
Automatic and Semi-Automatic Mercury Vapour Rectifier Sub-Stations (*Illus.*)	782
Marine Oil-Engine Trials (*Illus.*)	784
Society of Class Technology	786
Hydraulic Bending Press (*Illus.*)	787
ENGINEERING Patent Record (*Illus.*)	788

One Two-Page Plate and Two One-Page Plates.—STRAUSS BASCULE BRIDGE OVER THE BANN RIVER AT COLERAINE, IRELAND.

ENGINEERING.

FRIDAY, DECEMBER 5, 1924.

FACTORIES AND WORKSHOPS ACCIDENTS.

POPULAR publicists are prone to treat statistics in a singularly light-hearted way, and few seem to recognise the fact that a true understanding of them is seldom or ever to be derived without much more information than the tabulated figures convey as they stand. The difficulty which is ever inherent in the interpretation of statistics, is yearly exemplified by the reports to the Home Office of the Chief Inspector of Factories and Workshops. Although the personnel of the staff and methods of compilation change but slowly, there is nevertheless no certainty that the accident statistics for different years are fairly comparable, since there is a steadily-increasing tendency to include in the list, trivial mishaps, which a generation ago would have been ignored in all reports, and which to-day are still ignored in some. The report for 1923 states that the total number of accidents during the year was 125,551, a figure which is 27,565 in excess of that for the preceding twelve months. The inspector reports, however, that though the increase is in part due to greater employment, an important factor has been the more complete reporting of accidents. It may be said, however, that the fatalities provide comparable figures. These numbered 867 last year, which may be compared with 951 in 1921 and 1,404 in 1920. In both these latter years, about one accident in 100 proved fatal, so that the proportion of fatal accidents, which is the only reliable criterion of danger, appears to be continuously diminishing. A notable instance of how misleading a mere enumeration of accidents may be, is afforded by the figure given for accidents arising in the working of lathes. The report states that there are more accidents with lathes than with any other type of mechanism. This, as it stands, would seem to indicate that the lathe is an exceptionally dangerous tool. It turns out, however, that some $\frac{1}{12}$ of the total are "eye injuries," and of these probably not one in a hundred would have been reported as an accident a generation ago. Tiny fragments of metal are apt on occasion to fly into the eye of the turner, but in days past a neighbour removed the intruder with a large pin or the blade of a pen-knife, and work was resumed within a few minutes. Nowadays, the same mishap may mean a journey to an ambulance room, and is thus duly recorded as an accident. Many other lathe mishaps are equally trivial, and the report, unfortunately, does not state the number of lathe accidents which proved fatal. Possibly, there were none. It is pointed out, however, in partial explanation of the long casualty list, that there are probably more lathes in use than any other class of tool.

It appears that some 45 accidents were due to persons getting their clothing entangled in stock projecting from hollow spindle lathes. In the old days, probably little real danger arose from the lack of guards to these, but of late years speeds and cuts have been increased, and much more power is supplied to the machine, so that it is easy to understand that in such cases the projecting and rapidly revolving stock may be as dangerous as unprotected shafting.

It appears from the report that falls are a prolific source of acoident, and two-thirds of these were due to falls on the level, arising either from slippery or uneven floors, unsuitable footgear, or from "skylarking" amongst the operatives. In the case of woodworking machinery, the dangerous character of which has long been recognised, there are official regulations requiring non-slippery floors in the vicinity of the machines.

The power press is becoming year by year a more and more important factor in industry. Work, marvellous in intricacy, accuracy, and cheapness, is now being manufactured on an enormous scale by the use of the power press, which as originally built was undoubtedly a dangerous tool, though probably not responsible for many actual fatalities. The guarding of the dies has proved a matter of some difficulty, and no one method is suitable for all patterns of the machine. These range in size from those used in cutting and forming motor-car panels, which may have a feed opening of 6 ft. and a stroke of 3 ft., down to the small presses used for the mass production of tiny parts of instruments, in the working of which any serious accident would hardly be possible. The main danger with the sizes of machine most in use is to the operatives' hands. In some cases fixed guards can be used, but these, to be satisfactory, must be such that the operator cannot get at the tools when the machine is at work. Where access to the space between the dies is necessary in the operation of the machine, a moving guard is fitted which sweeps the space clear before the dies close. One worker of a machine thus fitted is quoted as observing that she supposed it was all right, "only it keeps knocking my hands out of the way!"

There were a good many cases of burst grindstones during the year, 25 being reported in the Sheffield area alone. This figure is rather above the average, and the increase is attributed in part to the scarcity of money, which has led to the use of stones in a comparatively green state. In addition to this, there has been an increased use of soft stones, as these are said to be "kinder" to "stainless" steel. The inspector reports, however, that the grinding, glazing, and polishing of table cutlery by mechanical means is making headway and promises to lead to the elimination of natural stones for grinding purposes. As usual, dangerous abrasive wheels are more prevalent in the smaller shops, and in motor-repair establishments in particular, improperly protected, badly mounted, and over-speeded wheels are not uncommon.

The growing popularity of the internal-combustion engine has led to a reduction in the number of steam boilers worked under improper conditions. The obligation to have boilers inspected by a competent man is, however, at times ignored by the smaller factory owners, who, to avoid the expense of an inspection by a boiler insurance company, entrust the work to a local examiner of doubtful competence. The internal-combustion engine has, however, introduced some new dangers, though the net risk is certainly less than that attaching to steam boilers improperly looked after. The report mentions

an explosion of the air-blast injection pipe of a Diesel engine, and in another case a fatal explosion occurred when a semi-Diesel engine was being run on trial. There have also been several explosions in the furnaces of oil-fired boilers, and one case is reported of an explosion where pulverised coal was being used.

There have been a good many explosions of compressed gas cylinders. Some were due to defective material, a notable case being that of three cylinders removed from a German submarine. These were 16½ in. in diameter and ⅝ in. thick, and after testing at 3,000 lb. per square inch were charged at 1,800 lb. per square inch. The explosion occurred, however, when the pressure was only 1,500 lb. per square inch, and an examination of the material showed the steel to be of inferior quality and in one case very brittle. Welded bottles are not considered suitable for storing compressed gases as defective welds are far from infrequent. There have been several explosions due to the use of unsuitable lubricants in compressors. For such purposes "a high flash straight mineral oil" is recommended, as vegetable and animal oils are apt to fire when exposed to compressed air at a high temperature. In any case the amount of lubricant used should, it is recommended, be as small as possible. Where oxygen is being compressed, still greater precautions are necessary, and the report states that the cylinders of oxygen compressors are generally lubricated solely with distilled water. In America, however, it has been considered safe to add small quantities of soap solution to this, provided the soap contains no free fat. An explosion, however, occurred last year which was definitely traced to the addition of 0·07 per cent. of soap to the lubricating water. This soap had been specially prepared and proved free from fat on test. The explanation given of the explosion is that a copper soap was formed in the compressor, the alkali, originally present, being replaced by copper dissolved from the valves. This copper soap broke up during the working of the compressor liberating hydrocarbon vapours. The copper oxide thus set free was deposited on the piston and caused heating by friction, which was sufficient to ignite the vapours. The oxygen, it should be added, was electrolytic and contained 1·8 per cent. of H.

The report states that factories continue to increase in numbers and the workshops to diminish. The distinction between the two lies in the use of power, undertakings where no power is employed being classed as workshops. The change over is highly desirable, as from American returns it appears that in pre-war times our use of power per man employed was only about one-third as much as the average in the United States. It was, no doubt, this lavish use of power which enabled so many American industries to maintain a foreign trade in spite of the very high wages paid. The change here is being hastened by the extended use of electricity, and though accidents do occur in connection with electric power it is gratifying to note that they number considerably less than ten years ago when the demand was not one-third of what it is to-day. Comparative figures are 361 accidents (of which 22 were fatal) in the year 1923, and 472 accidents, of which 19 were fatal in 1913, Most of the accidents occur with supplies at moderate pressures and the number is being increased by the steady substitution of the alternate current for the direct current. There would thus seem to have been some basis for the newspaper campaign waged in America some 30 years ago against what was called the "deadly alternating current," although that agitation was really promoted and financed by industrial organisations interested in the direct current system.

Most of the accidents appear to be due to ignorance, particularly amongst small users. It appears, however, that at least one large new station disclosed extraordinary recklessness in its arrangements, the switch room being "truthfully described as a death trap." Extra high-pressure conductors were exposed without any protection in places where attendants would, in the ordinary course of their duties, be liable to come in contact with them and there were other nearly equally serious defects in the arrangements. The growth of existing stations has called attention to the necessity of scrapping and replacing switches, circuit breakers, and the like, which are no longer adequate, in view of the heavier loads. On large systems the explosion of an oil switch may have serious consequences. In one case reported, the sub-station walls were blown out, and the station demolished. In other cases the vent pipes from the switch gear have been located in such a way as to endanger the staff. It is recommended that they should in all cases be carried outside the buildings.

The establishment of a number of outdoor substations is reported, but doubts are expressed whether in this climate, the saving in the cost of buildings will compensate for the cost of maintaining the apparatus weatherproof.

The bursting of a 3,000-kw. turbo-alternator, and of another of double the capacity is recorded. Fortunately no one was hurt.

The report states that the eight-hour day is now general, and that any attempt to return to longer hours would be strongly resisted. In certain cases only five days are worked per week. Some firms have adopted the two-shift system, but the reports on the working of this are very conflicting. The views of the operatives depend a good deal on their nearness to the factory and on transport facilities. The great improvement which has been effected in this regard during the last few years, has made it possible for factories in large towns to draw labour from surrounding villages. In some cases, however, the interests of the town and village worker conflict. Thus, at Leicester the mid-day break is 1½ hours, which is a convenience to those who live in the town, whereas those who come from a distance would prefer a shorter interval, and to get away at a correspondingly earlier hour.

At a meeting of the British Association at Leicester in 1907, papers were read in which attention was drawn to the extraordinary nimble-fingerness of young boys and girls engaged in light repetition work, and it was suggested that equivalent results could not be secured with older operatives. In the textile trades, too, it has been contended that learners in the weaving sheds should start at 12 years of age because of the flexibility of their fingers. It is, therefore, of interest to learn that two firms at Bolton have successfully undertaken the training as weavers of girls aged from 17 to 25.

Welfare work apparently makes steady, if slow, progress. For the slowness, trade depression and perhaps also the heavy taxation is largely responsible. Workers are becoming less prone to mis-use and wreck the facilities provided, and managers are learning that supervision is essential to keep messrooms and toilet-rooms in a satisfactory condition. It is gratifying to note that washing accommodation is being more generally provided, and is being more and more appreciated. In time we may hope to attain in this respect to American standards.

COASTAL TRAFFIC.

The average person in this country is apt to forget that a large volume of traffic finds its way from port to port round our coasts, by sea. So accustomed are people to think in terms of rail transport, that other systems are often overlooked except when some enterprising firm of road hauliers canvass for their patronage, or some enthusiast for the moment arouses interest in the possibilities of canals. At intervals the coasting trade is threatened with extinction, and the public is then apprised of the fact that one of its most vital interests is at stake. Soon after the war, the trade was in great difficulties; the reason was not far to seek. Prices generally were then very high; the only direction in which they had not been raised to a commensurate degree was that of railway rates, due essentially to the fact that those systems were under Government control at that time. This gave the railways an immense advantage in securing port-to-port traffic, though, as all rates were unremunerative at the time, the real gain to them amounted to practically nothing, while the loss to shipping may well have been severely felt.

According to Sir Alfred Read, who read a paper on the subject on Monday last, before the Institute of Transport, the coastal shipping trade is again fighting for its existence. Sir Alfred mentions competition with the railways and with road transport. He fails to mention, however, that under the Railways Act of 1921, the coastal trade is protected from undue competition in connection with rates, on the part of the railways, who in this matter are working under supervision. It may be recalled that when the clause was inserted to protect the shipping interests, in order to serve all alike, the attempt was made to secure some protection for the railways against competition by road. This, finally, was considered to be unworkable, and the railways were left to work out the best means of combating the methods of their latest rivals.

Such competition as now exists between the railways and coastal shipping arises under these conditions mainly from facilities. The fact is that shipping suffers under certain inherent disabilities. Originating very many years ago, at a time when cross-country transport was well nigh impossible, and when it provided the only feasible method of transport in bulk, this trade has survived in what is really a remarkable manner, in view of the internal changes which have come over the country. Stage coaches were driven off the roads by the provision of better facilities. Canals always suffered from physical features by which the railways were unfettered, and in time succumbed. Shipping, however, has made a good fight of it and has adapted itself as far as possible to the changed times. It is a cheap form of transport, and its survival is due to just how far this can offset its disadvantages, in relation to the facilities offered by other systems.

For certain traffic the low cost will probably always give it the advantage, but, with the increasing demand for speed and for convenience of service, it is probable that, relatively, this trade will continue to fall off. Even in the traffic between the smaller coastal ports the stress of competition is now felt. Here it is probably a case of road transport, which offers its unrivalled door-to-door service, most likely using a direct route, thus ensuring quick delivery in directions never attempted by railways, whose systems run more to points inland than between places on the coastline.

Sir Alfred Read's paper draws attention to some of the difficulties to be contended with. For instance, in order to keep cartage costs low it is pointed out that docks and wharves utilised must be in the centre of the ports served. This at once directs attention to the fact that, if cartage is relatively high, the balance of advantage can easily be lost by shipping to the railways or to road transport. Then, again, it is stated that ships should be able to enter ports to unload, and leave, at any state of the tide. This seems hardly consonant with the requirement as regards cartage, without the provision of expensive works, the cost of which would be bound to be reflected in harbour dues. This would not provide a clear economic gain, therefore, and the traffic might fail to survive as a result. The same applies to the demand for the provision of greater facilities, two-storied sheds at the docks, cranes and mechanical devices for loading and unloading rapidly, and so on. All these can be provided, but at a price, and the question is how far it will pay the ports to spend money in this manner. Such expenditure has to be recouped in one way or another. It is for the shipping people to convince the ports that this can be accomplished in a manner which will be mutually beneficial, for if a port overburdens itself with heavy dues, and shipping consequently forsakes it, its last state will be worse than the first, and the only parties benefitting will be the very road and rail transport systems from whom the shipping companies are seeking to conserve their traffic.

THE DETERIORATION OF STRUCTURES IN SEA-WATER.

The Committee of the Institution of Civil Engineers, which since 1916, with the help of grants from the Department of Scientific and Industrial Research, has been investigating the deterioration of structures in sea-water, has prepared a Fourth Report, which has now been published for the

Department in succession to the Reports of 1920, 1922, and 1923.*

It will be remembered that these investigations include both laboratory and other observations made in this country, and records of continuous exposures in various ports of the Empire. The present report consists of interim accounts of progress from correspondents of the Committee, with abstracts of reports received from various American authorities on allied investigations in the United States. No final results have been reached in the period under notice, but information continues to accumulate and encourages the hope that the inquiry will ultimately lead to a considerable advance in knowledge of a complex subject, in which definite information can only be gathered by prolonged and systematic observations.

The results that at present are the least definite, but by no means the least interesting, relate to the life history of teredo and other animals that attack timber, and to some damage to brickwork in the port of Calcutta caused by bivalve molluscs. Observations on teredo were made at Plymouth in continuation of the investigation by Mr. Harington under the direction of Professor Barger, carried on last year by Mr. C. M. Yonge. The attempts to induce the animals to grow under laboratory conditions were only partly successful, as, although fertilisation and growth were induced and the larvæ were attracted by strips of wood and crowded on them, the conditions of experiment did not succeed in producing any boring action or any transformation of the larvæ preliminary thereto. The experiments threw light, however, on some circumstances of the development of the larvæ, and apparently are to be continued until the right conditions for enabling the larvæ to complete their life history are found. Meanwhile a raft that had been exposed in Plymouth harbour since 1920, bearing small battens of untreated deal, and had shown no signs of infection after a year's exposure, was again examined, and this time the battens were found without exception to be riddled with teredo and other animals. Where possible the burrows, and the contracted teredo removed from them, were measured. Observations were also made on a number of specimens of timber treated with various chemicals, the results of some of which are decidedly encouraging. All these observations were made at sea under some difficulty, and it is intended after another year's exposure to bring in the entire raft for a full examination.

Similar experiments have been continued at Lowestoft by Professor S. M. Dixon, with analogous results, and it seems likely that some definite information as to protective processes may be available when the next examination has been made. The Lowestoft experiments are being continued, and a further set of specimens have been sent to Colombo for exposure. Professor Dixon has also made a number of bending, end and side compression, and shearing tests on various foreign timbers with and without preservative treatment. This series is still in progress, and the results are to be published in a later report. Professor Dixon is also conducting a number of observations on a miniature air-drying apparatus for timber, the design of which is included in the present report. The specimens are 8 in. by 2 in. by 12 in., six such blocks being dried at one time. The essential feature of the design is that the air used for drying is kept in a suitable state of humidity so as not to case-harden the outside of the blocks. This is done by means of a controllable water spray passed by a fan into the heating chamber from which the air for drying is supplied to the kiln. Temperatures are controlled by thermometers, but no mention is made of means for measuring the percentage of moisture in the air before or after humidification and on discharge from the kiln. The process is continuous, and is said to produce a uniform drying, which avoids the cracking through unequal shrinkage found commonly in seasoning hard woods.

Mr. W. H. Hamer, Engineer to the Auckland Harbour Board, continues the account of specimens of native and other timbers, treated and untreated, that have been exposed in the harbour since 1917 and 1918, showing every kind of extent of attack by boring organisms, from complete disappearance of the timber up to entire soundness, the latter condition being found only in some treated specimens. Particulars are also given of some timbers exposed similarly to decay in the ground; several of these, both treated and untreated, remain quite sound, though a number are slightly attacked, and at least one has rotted right through.

The damage to brickwork is reported by Mr. J. McGlashan, the Chief Engineer to the Port of Calcutta, and a detailed note on it by the late Dr. Annandale, Director of the Zoological Survey of India, is appended. The damage was done by the penetration of small bivalve molluscs of a recognised variety into the brickwork of a culvert in the Kidderpore dry docks. The molluscs were found not only in the mortar but in the brickwork itself, which they penetrated for as much as 1 in. to 2 in., and would indeed have probably destroyed the entire mass but that, apparently through foulness of the water arising from impure effluents, most of them had died off. They seemed unable to attack the bricks except where the blue glaze on the surface had been omitted or worn off. The burrows were bottle-shaped with the neck at the entrance, and in one instance the base of the bottle was some 17 mm. as against little more than 1 mm. at the entrance. Ordinarily this bivalve bores in wood, though it was found originally in soft argillaceous sandstone. Where it had penetrated, other molluscs were beginning to collect in the holes it had made, and if they had accumulated and increased, as might have happened, would have carried the destruction of the brickwork further by breaking down the thin walls between the burrows of the original bivalves.

A summary note by Mr. L. H. Savile, Civil Engineer-in-Chief of the Admiralty, describes the results of an investigation into defects in reinforced concrete structures at Admiralty establishments, ascertained in consequence of a defect observed in one such structure. The chief remedial measures ordered to be taken in future are to use a minimum of 2½ in. cover for the principal members, the concrete being so proportioned as to give maximum density and the aggregate all to pass through a ¾-in. ring, to avoid the use of flat steel stirrups or links and overcrowding of reinforcements, to coat the surface of the concrete with paint, fuel oil, or composition, for preventing the percolation of air, water, &c., and to prohibit the use of salt water for mixing the concrete.

A considerable part of the report is devoted to notes on various corrosion observations that have been in progress and are being continued. Dr. J. Newton Friend reports his laboratory observations on the corrosion of certain specimens of steel prepared by Messrs. Hadfields, some in their ordinary condition and some mechanically overstrained. The results of a year's exposure to artificial seawater are set out, and compared with those of a previous series, in which the same materials had been exposed for a year to fresh water alternately wet and dry. The results show differences in the relative resistance of the several metals to the two conditions, and further differences seem to be disclosed on comparing them with other results that have already been reported from the river and sea tests in progress. Abstracts are given of reports by Mr. L. H. Savile, Mr. W. H. Hamer, Mr. A. D. Prouse, and Mr. C. E. W. Dodwell, the engineers to the authorities concerned, on the steel specimens under observation at Devonport, Auckland (N.Z.), Colombo, and Halifax (N.S.) harbours.

A special report by Mr. Ernest J. McKaig and Dr. J. N. Friend describes an interesting instance of corrosion of iron and steel in a landing stage at Weston-super-Mare, which from its completion in 1908 had shown signs of active corrosion, especially in bolts and nuts, and ultimately early in 1922 showed fracture of weakened members and had to be dismantled. The cause of the rapid corrosion was not definitely established, but appears to have been connected with a slight erosive action of sand about sea bed level, which constantly exposed fresh surfaces to corrosive action. The fracture is attributed to repeated reversed stresses caused by the impact of vessels using the stage. Cracks were thus developed which allowed salt water to penetrate into the interior of the metal. Specimens of uniform steel plates, all rolled from the same ingot, have been prepared and coated with various protective compositions under the direction of Dr. Friend, for exposure in Southampton by Mr. F. E. Wentworth-Sheilds, the Docks Engineer to the Southern Railway Company. Analyses have been made of the pigments, oils, diluents and steel. These will appear in a subsequent report with the results of exposure.

Useful abstracts are given of reports received from various American authorities, in particular from San Francisco and from Barnegat Bay, N.J., where very active attack by a small teredo has been observed. Abstracts are also given of biological researches on teredos and shipworms.

Additions have been made to the museum of organisms found on exposed timbers, and the Committee hope to secure the help of corresponding members in enlarging the collection, which is carefully catalogued, as complete as possible.

THE CITY AND SOUTH LONDON RAILWAY.

ON Monday last the City and South London Railway was again brought into service, being then formally reopened after reconstruction which has transformed the old pioneer line into what is claimed to be the finest underground railway in the world. The line is one of great historic interest since it was the first tube railway of its kind, and the first underground system to employ electric traction. The line owed its existence directly to Greathead, while Edward Hopkinson was responsible for the work which made the adoption of electric traction upon it feasible, in place of the cable system originally planned.

In his presidential address recently delivered before the Institution of Civil Engineers, Mr. Basil Mott paid a high tribute to Greathead and recorded many interesting points connected with the original line, as well as with the work of reconstruction, for which Messrs. Mott, Hay and Anderson have acted as consulting engineers. At the luncheon which followed the opening ceremony on Monday last the names of Greathead and Hopkinson were likewise honoured.

The original City and South London was opened in December, 1890. The tubes, with cast-iron lining, were 10 ft. 2 in. and 10 ft. 6 in. in diameter and the trains were hauled by locomotives, one of which now reposes as a relic of historic interest in the South Kensington Museum. The station tunnels were single tunnels 30 ft. in diameter, lined with brick. In the reconstruction the tube tunnels have been enlarged to take the standard tube rolling stock of the London Underground Railways. The new diameter of 11 ft. 8¼ in. brings the line into conformity in this respect with the other railways making up the system. Although as we have said the original line had tubes 10 ft. 2 in. and 10 ft. 6 in. in diameter, extensions had been built to a diameter of 11 ft. 6 in. In the reconstruction these have also been rebuilt to the present standard, this work having been done by hand, with timbering, the old lining being replaced with enlarged key pieces.

For the enlargement of the smaller diameter tubes working with shields was adopted, no less than 18 shields being simultaneously in operation at one period. On curves the tunnels are enlarged to 12 ft. and 15 ft. diameter, according to radius. For the chief part of the section between Clapham and Moorgate the work was carried out without stopping the traffic. This involved the use of a special type of shield, but the worst complication arose from the fact that signalling gear and other equipment had to be removed at any point where work was in progress, before a start for the night could be made. This had all to be restored before traffic could be resumed in the morning. Work of this kind was necessary at as many as sixty points at a time—a fact which will give some idea of the organisation necessary. At the stations the

* "Deterioration of Structures of Timber, Metal and Concrete exposed to the Action of Sea-water." Fourth (Interim) Report of the Committee of the Institution of Civil Engineers. Edited by P. M. Crosthwaite, M.Inst.C.E., Secretary to the Committee, and Gilbert R. Redgrave, Assoc.Inst.C.E., H.M. Stationery Office. 3s. 6d. net.]

old 200 ft. large diameter tunnels have all been lengthened to 350 ft., to take the present standard length of train. It may be mentioned that on the southern section some four-fifths of the excavation was carried out with traffic still working. Subsequently, owing to a subsidence, the line was closed to traffic and handed over wholly to the work.

For the handling of the spoil, trains were used operated by the old locomotives. The material was hauled to the Stockwell depot, where there exists a 20-ton hydraulic lift originally installed for lowering the rolling-stock into the tunnels. This lift handled in all some 62,400 wagon loads, covering 95,000 cub. yards of excavated material and 14,000 tons of lining segments.

The work has been carried out under the Trade Facilities Act, and has given direct employment to a large number of men. At one time 2,000 hands were employed on the undertaking, while the indirect employment has been estimated at about 5,500 men over a period of two and a-halt years. British products were used throughout.

With the completion of work now in progress the line will become the longest railway of its kind, involving a total of 21 miles, whilst the tube section from Golders Green to Colliers Wood will constitute the longest railway tunnel (14 miles) in the world. The line will ultimately extend from Edgware to Morden on the south, and with the new connection now in course of construction between Charing Cross and Kennington, a new direct route from north to south across London will be available, cutting out, for those who may desire to avoid it, the detour by the City and the Angel. The travel facilities in London will thus be greatly enhanced.

Concurrently with the underground work, the reconstruction of the stations has been taken in hand. All of these have been greatly improved in the process of remodelling—some have been completely rebuilt, while two entirely new ones have been constructed. At the new Clapham Common station a feature is the installation of an escalator of the new cleat-comb type, the first of its kind in England, enabling passengers to step directly on to the stair, instead of on to a moving level platform. The contrast between the spacious escalator and station premises and the accommodation and lifts formerly provided is very great. No less does the rolling-stock contrast with that of the former days. The original City and South London passenger stock was pratically without windows. It was argued that as the trains ran always in tunnels side lights were a superfluity, and only narrow glazed strips a few inches deep ran along each side, the upholstered backs of the seats being carried to a considerable height up the carriage sides. The new stock, on the other hand, is very light and airy, with plate-glass side lights capable of being lowered some inches. Of course, the conditions now are different from those of the original line, as the railway when complete will be a surface line for some distance at both ends. The new stock is remarkably quiet in running, and proves how excellently the measures for the suppression of avoidable noise, have been carried out by the mechanical department.

We may conclude this brief notice of an interesting work by mentioning that the line has been reopened six months earlier than was expected, and with a reference to four of the company's officials whom Lord Ashfield cited, at the luncheon following the opening, as being directly responsible for sections of the work, viz., Mr. Z. E. Knapp, director of construction; Mr. A. R. Cooper, chief engineer; Mr. S. A. Heaps, responsible for the architectural features of the work; and Mr. I. J. Jones, resident engineer.

NOTES.

Cooling Towers.

A comparatively recent example of the applicability of ferro-concrete is afforded by its use in the construction of cooling towers. The subject was dealt with in a paper entitled "Recent Developments in Ferro-Concrete Cooling Towers," by Mr. H. A. Rickwood, read last Monday, at a meeting of the Society of Engineers. The author first comparing timber and steel cooling towers from the point of view of their life, stated that in France a timber shell was generally assumed to last from 10 to 12 years. In Holland opinion was divided, some engineers considering 8 years to be the limit, whilst others believed that with care and proper maintenance timber towers would last 15 years. In this country, the paper stated, 12 to 15 years was the life generally relied upon. Efforts made to provide cooling towers of more resistant material led to them being constructed of steel. The Worthington-Simpson towers were of this material, both as regards the shell and the interior. They were circular in shape, the diameter seldom exceeding 25 ft., the height being from 90 to 100 ft. Reinforced-concrete had been resorted to for the construction of the outer shell as a substitute for steel, and a few Worthington-Simpson towers had been built of that material on practically the same lines as the steel towers. The recent development in the construction of ferro-concrete cooling towers referred to by the author was due to Professor F. K. van Iterson, Director of the Dutch State Mines, Heerlen, and Mr. G. Kuypers, Chief Building Surveyor, Amsterdam, who have provided them with collecting tanks of greater capacity than hitherto usual, with a view to improve their working. The towers have a base 28 m. (92 ft.) in diameter, their height is 35 m. (about 115 ft.), the inside diameter at the neck near the top being 10 m. (about 33 ft.). Radiating troughs and concentric gutters are built in the lower part of the tower. The inlet pipe delivers in the centre, the water being carried towards the outer part by means of the troughs which feed the gutters, the latter being arranged in parallel concentric lines, each of the 8 triangular gutter sectors being fed equally. The interior of the shell above this bottom filling of troughs and gutters is free from all stays and bracings, there being, therefore, no resistance to the air draught. The base of the shell underneath the troughs and gutters is made with circular or triangular openings for the incoming air. The new towers are found to work uniformly over their whole area and to give complete satisfaction from the point of view of cooling efficiency.

Rubber Latex and its Applications.

It is a curious fact that a good many rubber manufacturers of this country had not seen any rubber latex, the milky sap as it leaves the tree, until the London rubber exhibition of 1922. The rubber arriving here had always been in the coagulated condition; if not coagulated on the spot by heat, smoke or acids, generally acetic acid, the milky sap coagulated during transport. Yet it was known that alkalis and especially ammonia would not coagulate the rubber, but preserve it to a certain extent; a patent on the preservation by ammonia had indeed been taken in 1853, a patent on the use of rubber "in its native state" had been obtained by Peel in 1791, and Hancock and others had experimented on latex. A few years ago Mr. F. Kaye improved the strength of paper by introducing latex during the beating process of paper making. In 1922 the imports into Europe of latex from the Malay and Sumatra districts suddenly went up to 1½ million gallons, and rubber manufacturers generally became interested in their primary raw material. The problems were discussed on the 17th ult. at a joint meeting of the Institution of the Rubber Industry, and the Society of Chemical Industry in connection with a paper by Dr. A. van Rossem, director of the Government Rubber Laboratories at Delft, Netherlands, on "Latex, its Chemistry and the Development of its Industrial Applications." The 1,500,000 gallons of latex of 1922, Dr. van Rossem mentioned, represented one per cent. of the total rubber imports from that district for the year, but the figure for this year would be very much smaller. The latex had, at Delft, been concentrated by evaporation and by centrifugal processes which yielded "latex cream" and "skimmed latex." Latex could be vulcanised, the best sulphur carriers being colloidal sulphur and ammonium sulphide, and it had found applications, especially as a substitute for rubber solutions, the solvents of which could only be recovered by costly and dangerous processes. The waterproofing, by means of latex, of paper, leather, threads and tubes, balls, and of tarpaulin and cement bags were promising applications, and high-pressure steam packings of latex had given good results. The concentration of latex might prove of advantage, particularly as three tons of latex contained two tons of water. Dr. van Rossem himself was doubtful whether the little rubber contained in latex paper would prove durable. But Mr. Kaye mentioned that paper samples he had received from the American Bureau of Standards had not deteriorated at all in two years, and though that question must be left to time the many specimens of native latex articles in European museums are certainly still in perfect condition after decades of exposure.

ENGINEERING SCHEMES IN PARLIAMENT.

The private Bills to be brought before the session of Parliament just opened are still fewer than they were a year ago. In part this cessation of activity is no doubt to be attributed to the establishment of the Electricity Commission which, although its powers are less than is in the national interest advisable, have done and are doing excellent work in checking the multiplication of small and inefficient stations. Unfortunately, as matters stand the Commission has often to compromise with vested interests or local political considerations, and accept schemes and arrangements which are not quite the best from technical and economic standpoints. The only sufferer by the change has been the Parliamentary Bar which, however, promises to have some solace this year in the fact that two great companies are promoting conflicting schemes for railway development in Nottinghamshire. It is much to be wished that the two companies could agree on a joint scheme, and so reduce parliamentary costs, a form of expenditure from which the community reaps perhaps less benefit than many others that could be named. In his recent presidential address to the Institution of Civil Engineers, Mr. Basil Mott pointed out that in the great fight over underground tubes for London, in 1900-1902, some 100 miles of new construction were proposed and only four miles sanctioned. Amongst the scheme rejected, through the misapplied ingenuity of counsel, there were, Mr. Mott said, many really excellent proposals. Economic conditions to-day are not such as to warrant these expensive contests.

Railways.

The two schemes referred to above are promoted respectively by the London and North Eastern Company and the London Midland and Scottish Company. The former propose to construct in all over 30 miles of new line in the area lying between Nottingham and Retford, passing through Farnsfield, Boughton, and Houghton. In connection with this scheme the Derbyshire and Staffordshire line is to be widened in the Gedling area just outside of Nottingham. In a second bill the Company propose in addition, the construction of about 1½ miles of new line in the Southwell area, and also to widen here their Chesterfield and Lincoln branch. It is also proposed to construct about 10½ miles of new line from Gainsborough to Frodingham. In Derbyshire a little over a mile of new railway is to be made at South Normanton and Blackwell, and the Manchester and Sheffield Railway will be widened at Glossop. In Lancashire a new line about 2¾ miles is proposed between Whiston and Tarbock. Powers are also sought to divert the Middlesbrough Owners Line at Middlesbrough, and to widen Fenchurch-street Station in London for about ⅛ of a mile.

The London Midland and Scottish Company in their bill propose the construction of 14½ miles of new line from Retford to Farnsfield, passing through Bilsthorpe, Ollerton, and Boughton. There will be short branches or junctions at Ollerton, Boughton, Edwinstow and Balsworth, and two branches to Clipstone Colliery. The total amount of new line will be about 23 miles.

The Southern Railway has, of course, very much work in progress under its existing powers. These include important station improvements at Victoria, and the electrification of long sections of the suburban railways. It is expected that the Victoria-Coulsdon and Victoria-Sutton section will be in

operation by next February, and part of the South Eastern section, that from Victoria to Orpington, by July 1 and the remainder of the electrification now in progress will, it is hoped, be completed by 1926. With so much work in hand, the Companies are not launching out into extensive new schemes, and the bill they are promoting provides in the London area, merely for the widening of the Kent House and Beckenham junction line for about 1½ miles and also of the Norwood Spur Line. The Kent Coast line is also to be widened at Herne Bay for ¼ mile, and the Ryde-Ventnor line between Sandown and Shanklin for 1⅝ miles, and another clause provides for the construction in the Isle of Wight of 2½ miles of new railway near Ventnor.

Tramways, Light Railways, Trolley Vehicles and Motor Omnibuses.

One of the great difficulties attaching to municipal trading ventures has been the fact that if new developments render obsolete the methods and plans adopted on the assumption that finality had been reached, there is great difficulty in scrapping the latter. Many municipalities seem to be seeing in the trolley vehicle a way out of the awkward situation in which their tramway speculations have landed them. Whilst proposals for new tramways are few and unimportant, many corporations are taking powers to run trolley vehicles over existing tramway routes, and to abandon the tramways where rendered unnecessary by the new services. The change is all to the good, as the removal of the rails from the street will get rid of a frequent source of damage to other vehicles, whilst traffic generally will gain by the disappearance of the tramcar which is the cause of so much direct and indirect obstruction. The local authorities which seek powers for making the change above described are those at Barrow, Ipswich, West Hartlepool and Wolverhampton. Other authorities seeking powers to run trolley vehicles, in many cases over existing tram routes, are those at Bolton, Darlington, Nottingham, Walsall and Wallasey. In several cases powers are also taken to run ordinary motor buses. Powers for operating this latter form of transport are sought by the corporations of Rochdale, Hartlepool and Leeds, and the Urban District Council of Bedwelty. As already mentioned not much is proposed in the way of new tramway developments. The London County Council merely seek powers for new junction lines in the Lewisham and Woolwich area, and the Middlesex County Council propose similar work at Acton and Finchley. Glasgow Corporation propose the construction of about 2 miles of new line mainly in short lengths. Leeds also seeks powers for about the same amount of new construction, and Liverpool appears to have in view considerable extensions of its system. Other corporations promoting tramway proposals are those of Sheffield, Nottingham, Burnley, Blackpool and Wallasey, but all appear to be of quite minor importance. It may be added that the Mansfield and District Light Railway Company is seeking powers to deviate lines No. 3, 4 and 5 of their Act of 1920 and to construct additional lines in Mansfield, Rufford and Bletchworth.

Street and Road Improvements.

Street improvements are for the most part of purely local interest, but it may be noted that the London County Council are seeking powers to acquire land for this purpose in the Strand, whilst the Middlesex County Council propose to construct a new street at Acton, and to undertake widenings at Acton and Finchley, whilst the Air Ministry are to construct a new road in substitution for part of Plough Lane, Beddington. For the rest it will be sufficient to mention that street improvements, many of them extensive, are proposed by the local authorities of Blackpool, Barnsley, Bath, Leicester, Leeds, Nottingham, Oldham, Oxford, Scarborough, Wolverhampton and Wallasey.

Proposals will be brought before Parliament for the construction of a number of new bridges. Thus, the Glasgow Corporation intend to build a new bridge over the Clyde in substitution for the South Portland-street Suspension Bridge. At Hull the corporation seek powers to replace the existing North Bridge over the River Hull by an opening bridge. The pipes and cables carried by the existing structure will be transferred to tunnels passing below the river bed. Another opening bridge is that proposed by the Port and Haven Commissioners of Great Yarmouth, which will be in substitution for the existing structure over the Yare. A bridge over the Ouse, between Airmyn and Howden near Goole, is proposed by the West Riding County Council, and the Nottinghamshire County Council have plans for a new bridge at Gunthorpe in substitution for the existing toll bridge there.

Water Supply.

Water supply proposals are of a very humdrum character. The Bradford Corporation propose the construction of a new dam at Stonebeck Up, in connection with their authorised Scar House Reservoir, and the Fylde Water Board seek powers to enlarge their Stocks reservoir on the River Hodden. The Urban District Council of Leek propose to construct a "Swainsmoor" reservoir on the river Churnet, and another, the "Bigwood" reservoir, by damming the Bigwood stream.

The Water Board which is responsible for the supply of Mid-Glamorganshire are putting forward a scheme for impounding the Pwllwy springs at Llansannor, and the Schwyll springs at Penybont. Another Welsh proposal is that of the Pontypridd and Rhondda Water Board for a new service reservoir in connection with their Taf Fechan supplies. The New Quay Water Company seek to construct impounding works on the Mill race leading to Rialton Mill and on the river supplying the same. In Scotland the Corporation of Kirkcudbright propose to reconstruct the outlet from Loch Whinyeon reservoir and to undertake new impounding works on the Glengap Burn. The Wemyss and District Water Board seek powers for an impounding reservoir on the Milldeans Barn at Kennoway. Water authorities proposing minor works such as wells, pumping stations and conduits are those of Bexhill, Burnley, Bull Bay, Higham and Hundred of Hoo, Mansfield, and Monks and Prince's Risborough, whilst the Corporation of Bolton have a scheme for the construction of two new service reservoirs, one within the borough and the other at Turton.

Docks, Canals and Piers.

It is proposed to construct a new wet dock on the east sands at Leith, and the Corporation of Findochty are also seeking powers for considerable harbour extensions, and for deepening the existing harbour. The Clacton-on-Sea Pier Company are putting forward plans for widening and extending the pier. The undertakers of the Aire and Calder Navigation propose the construction of about ⅛ mile of new canal to form a diversion of the existing channel of the Dutch River at Goole.

Electricity.

As already mentioned, electrical proposals are exceedingly scanty. The only scheme of any importance appears to be a proposal by private promoters for the supply of electricity throughout a considerable area in the counties of Bedfordshire; Cambridgeshire and Huntingdonshire. Apparently the power station is to be at Little Barford, where powers are sought for dredging and cleaning the Ouse, from which the supply of condensing water is to be derived. "Special orders" for the supply of electricity are also sought by the local authorities at Pressall, Colne, Ulverston and Hanley, and by private promoters at Abingdon, Biggleswade and Uckfield.

Miscellaneous.

A few gas bills are being promoted, mostly in connection with plans for charging by therms instead of by cubic feet. Some minor works extensions are also listed, and it may be noted that the Gas Light and Coke Company propose to take over the undertaking of the Brentford Gas Company.

An interesting proposal is that of the *Daily Sketch* and the *Sunday Herald*, which seek powers to lay a 4-in. pneumatic despatch tube from Gough-street to Farringdon-street.

SOMERSET OIL SHALES.

Every discussion on the future of the fuel resources brings up alarmists and optimists. Just before the war experts seemed almost agreed that the oil production and consumption could not be maintained at the actual ruinous rate. Such considerations were disregarded during the war, and since then the consumption has merely increased at a still more reckless rate. Yet there is less alarm, because the uncertainty of the basis of our natural storage estimates, and the possibility and need of a better utilisation of our fuels are more fully recognised. In dealing, on last Tuesday, in a paper by himself and by Mr. H. G. Shatwell, on the "Fuel Oil Resources of the Future," with the problems from both these standpoints, Mr. A. W. Nash, of the Oil Mining Department, of Birmingham University, raised questions of great interest to the Institution of Petroleum Technologists.

Mr. Nash pointed out that all the free petroleum had not yet been located, and new fields were continually being discovered, even in the United States, that speculations as to the likelihood of the formation of future oil fields remained vague, but not inadmissible as long as we were ignorant about the genesis of petroleum, and that the present methods of working may leave much more oil in the earth than they bring up. The success that oil-sand mining had achieved at Pechelbronn justified hopes for use of the tar sands of Alhabasca and other countries. Destructive distillations made oil shales, cannel coals and torbanites, lignites, peat and ordinary coal available as sources of fuel oils. The development of the enormous oil shale fields of Colorado and Utah had only been held back by the relative abundance of free petroleum, and oil shales were common all over the world. The oil shales of Somerset were the subject of a second paper subsequently read the same evening by Mr. Shatwell.

Having briefly discussed the tar and oil yields obtainable from cannel coal, lignites and peats, important in some countries, Mr. Nash passed to coal as a source of oil supply, to low-temperature carbonisation—the 50 million tons of small coal, waste or left underground, might yield millions of gallons of oil per year—and to the conversion of coal into oil by the hydrogenation process of Bergius and the corresponding experiments that they had been conducting at Birmingham University. By treating various kinds of coal with hydrogen at temperatures of about 400 deg. C. and more, under pressures of 100 atmospheres Bergius had since 1913 been converting powdered coals into liquids or partly into solids, which were more soluble in various reagents than the original material was. In order to facilitate the reaction Bergius mixed the powdered coal with some liquid medium and charged the resulting paste into the retorts. This was also found advantageous at Birmingham,

The second paper, on "The Somerset Oil Shales," in which Mr. H. G. Shatwell, M.Sc., was associated with Messrs. A. W. Nash and J. Ivon Graham, M.A., concerned the geology and distillation of oil shales on which Dr. Forbes Leslie* lectured last spring at Birmingham. The samples of Mr. Shatwell had been obtained from the north coast of Somerset, a stretch of 12 miles between Blue Anchor and Kilve (north of Taunton), where black and brown shale bands alternate with argillaceous lime-stones extending up to three miles into the land. The same Lias formations occur on the other side of the Bristol Channel, near Penarth, and samples from the South Wales oil-shale field, which is apparently of wider extension, have also been examined by Mr. Shatwell. In Somerset the shale bands are thicker, up to 20 ft. thick, than the lime-stone; in South Wales the oil-shales only attain a thickness of 5 ft. In both cases quarrying might first be applied but mining would soon become necessary; it was doubtful, Mr. Shatwell thought, whether the limestone would afford a safe roofing, and the base of the cliffs being below high water, water troubles might arise.

The figures of Mr. Shatwell's proximate analyses varied very much; Professor Brame, who occupied the chair in the absence, owing to illness, of Mr. Barringer, questioned the values of these "proximate

* Engineering, May 30, 1924, p. 714.

analyses" which are still common practice. Mr. Shatwell found in the shale oils from Somerset and Wales fairly big sulphur content (2 to 4·5 per cent.) and very high carbonates, but little lime. The spent shales would hence not give good cements unless mixed with much lime. Mr. Hackford showed afterwards, however, some cements said to be of excellent quality which he had obtained by leaving a relatively little oil in the shale. The redistillation of his oil shales Mr. Shatwell performed in the assay apparatus (electrically heated retort) of the Fuel Board and by the steam distillation device of Lomax and Remfry; the latter method was found preferable, as usual, for oil yield, if the oil yields were small (up to 10·4 per cent. maximum against 24 per cent. in parallel Scottish shale tests), and the ammonia yield were likewise low, at the best 7 per cent. against 23 per cent. Bulk tests were made with 2 gallons of crude oil from the tanks at Kilve. Practically no distillate was obtained below 100 deg. C, 2 per cent. passed between 125 deg. and 150 deg., 9·3 per cent. up to 200 deg., 24 per cent. up to 250 deg., and 44·6 per cent. up to 300 deg. Almost the whole of the oil was soluble in sulphuric acid and consisted therefore of unsaturated hydrocarbons. Mr. Shatwell described his experiments and tabulated his results, leaving members to draw their own conclusions. The refined light naphtha was and remained colourless, the heavy naphtha was stubborn and dark coloured, and darkened still more on standing. The most valuable fractions of the shale oil would, according to Dr. Leslie's paper quoted, be the lubricating oils. Mr. Shatwell obtained in his small scale experiments only traces of wax.

In the discussion of the two papers Dr. Ormandy pointed out that the Birmingham hydrogenation experiments did not carry the matter further than Bergius had done some years ago. Bergius had recently converted 90 per cent. of bituminous coal into oils containing 20 per cent. of petrol (boiling below 180 deg.), 20 per cent. of Diesel oil and lubricants, &c. He had also been successful with Mexican asphalts, and with lignite and asphaltic oils, both of which compounds Mr. Nash was going to study. As regards low-temperature carbonisation, Mr. Gordon Pitt criticised the yields of the Fuel Board, given by Mr. Nash, as quite inaccurate. Mr. Pitt said that he had quite recently obtained 30 per cent. to 35 per cent. of oil, containing from 10 per cent. to 20 per cent. of motor spirit, 30 per cent. of Diesel oil, &c., by a coal treatment costing 2*s.* per ton, and railway engineers had found the fuel oil 50 per cent. better than the original coal; the lateness of the hour—there was a long discussion—prevented him from substantiating his claims by figures, which are to be published in the Journal of the Institute. Mr. T. G. King replied that they had, at Greenwich, obtained 15 gallons of oil by low-temperature carbonisation of bituminous coal, and 8 gallons, possibly even 12 gallons, of that oil were recoverable as fuel oil; but he agreed with Mr. Nash that many misleading statements had been made as to the value of coal as a source of oil supply.

LABOUR NOTES.

The representatives of British organised Labour who are at present in Russia to convey the "fraternal greetings" of the Trades Union Congress to the corresponding body in that country, seem to have exceeded the mandate given to the General Council by the Hull gathering. They have agreed, to the setting up of a committee representing the British and Russian trade unions, to work for the establishment of world trade union unity. At the Hull Congress it will be recalled, Mr. Purcell, the President, asked for a mandate to call a conference on "unity" to which representatives of the Red International Labour Union would be invited, but the delegates rejected the proposal and clearly indicated that any steps taken in the direction suggested should be through the International Federation of Trade Unions—otherwise the Amsterdam International. A joint committee of British and Russian representatives, such as is now apparently to be set up, would presumably ignore the Amsterdam International, and thereby achieve an object which the Moscow International has for a considerable time cherished.

It will be interesting to see how the sectional Internationals, such as those of the miners, the textile workers, and the metalworkers, regard this new move. At the last Vienna meeting of the metalworkers the feeling was that until the Russians accepted the constitution of that International, they could not be allowed to affiliate. The representatives of the smaller countries, moreover, spoke rather bitterly of the efforts which the "Reds" were making to destroy existing trade union organisations. In this country, too, the aim of the R.I.L.U. is avowedly, as has been shown more than once in these Notes, to capture the unions in the interest of the Moscow International. In the latest issue of the *Worker*, for example, adherents to the National Minority Movement—which is, of course, the Red International Labour Union under another name—are told how to go about the business of capturing the unions to which they belong. The writer of an article on the front page says:—

"You must start decreasing that anti-N.M.M. majority in your branch—not just by standing up and making speeches at branch meetings, but in a dozen different ways—ways which will be suggested to you by the circumstances of your position. You can concentrate on two or three of the most intelligent members of your branch. Supply them with literature. See that each one of them is provided with a copy of the programme of the N.M.M. Then see that they get the *Worker* every week for a month or two. Pay for it yourself; you can afford the twopence or threepence a week. After a month you will probably find them eager to get the paper and to pay you for it. Engage these fellow-members in private discussion. Point out the errors and weaknesses of the present leadership and tactics of the union. Stress the necessity of a militant policy. And then, starting out from your own union and its immediate problems, lead them on to a realisation of the condition of the whole trade union movement and the necessity for its complete overhauling."

If the "complete overhauling" which is contemplated involves re-organisation in accordance with Moscow's policy, the constitutions of the British unions will call for drastic revision at which the Chief Registrar may look askance. The average British worker will, however, probably see to it that the achievement of the "Red" propagandists in their midst falls a good way short of that.

At the sixth Russian Trades Union Congress, which took place in Moscow last month, it was stated that the total membership of the Soviet trade unions had increased in a year from 4,547,000 to 6,036,000. Of that number 61 per cent. were manual, and the rest non-manual, workers. The number of women workers had decreased from 28 per cent. to 24 per cent., and that of juveniles from 3·7 per cent. to 3·1 per cent. although there was no absolute reduction of the number of women and juvenile members. Only 8 per cent. of the manual and non-manual workers were now unorganised, these being mostly Soviet and seasonal workers. The financial position of most of the unions was now, it was stated, quite satisfactory.

In the three months July–September, 1923, wages were 50 per cent. of pre-war; by the corresponding period of 1924 they had risen to approximately 72·5 per cent. The wages of industrial workers had risen during the past two years by about 63 per cent. In May and June of this year, although there was no rise in the nominal value of wages, real wages had risen, partly as a result of the introduction of piecework and partly because of a fall in the cost of living of 7 to 8 per cent. It was computed that, apart from the municipal and other privileges enjoyed by the workers, wages were now on an average about 75 per cent. of pre-war. The system of submitting disputes to conciliation boards and dispute commissioners was stated to have proved very successful. The number of disputes in 1923–24, as compared with 1922–23, had decreased considerably in State industrial enterprises but in private enterprises there had been an increase. Most disputes were now, it was added, settled by arbitration.

An interesting analysis of the fatalities for a year is given in the October *Industrial Bulletin* of the Industrial Commissioner for New York State. Of 1,780 claims filed for the whole State, 1,058 came from the New York City area. The industry classification shows that metals, food and wood manufacturing caused more deaths than the other manufacturing industries. Among the non-manufacturing industries the order of numerical importance as regards fatal injuries to workers was as follows: construction, transportation, service, trade. The cause classification shows that falls were responsible for 245 deaths. Falls from ladders, scaffolds, and other elevations took 125 of this number of lives. Of special importance as a cause of death, in the opinion of the Commissioner, is the great number due to falls on level surfaces owing to obstructions and defective surfaces. Forty-three deaths were attributed to this cause in the period under review. By the expenditure of a comparatively small sum of money and the exercise of proper care in enforcing safe practices, it is probable, he says, that some of these lives could have been saved. All the falls from windows reported for the State occurred in New York City, and almost all the 16 employees who lost their lives in that manner were window-cleaners.

The handling of objects resulted in death in 117 instances in New York City District, in 13 instances in Albany District, in 19 instances in Buffalo District, in 11 instances in Rochester District, and in 15 instances in Syracuse District. The workers killed in this manner were struck by the objects which they handled or were strained in the course of handling them. These accidents suggest the need, the Commissioner says, of careful investigation in order to ascertain whether the introduction of machinery is feasible. In 20 cases death was due to electrocution—9 in the Albany District and 11 in the Syracuse District.

The position of the railway managers on the question of the prospective increase of the express enginemen's daily mileage from 140 to 150 has now been explained to the executives of the Associated Society of Locomotive Engineers and Firemen and the National Union of Railwaymen. The managers say that they see nothing to justify any departure from the decision of the National Wages Board or the terms of settlement of the January strike or to cause them not to introduce the 150 miles basis next month. If, however, the representatives of the men desire to submit the matter again to the National Wages Board, they will, they say, raise no objection. It is understood that the unions are agreeable to refer the matter to the Wages Board.

The Ministry of Labour reports a further decrease in unemployment of 18,599. The number of unemployed persons on the registers of Employment Exchanges in Great Britain on November 24 was 1,190,400—909,800 men, 31,400 boys, 220,800 women, and 28,400 girls. On November 17 the number of unemployed persons was 1,208,999—921,986 men, 33,222 boys, 224,298 women, and 29,493 girls. As compared with the position at the beginning of the year, there is a falling off in the total number of unemployed persons of 95,423.

At the fifth meeting of the Committee on Industry and Trade, held on November 26, evidence was submitted on behalf of the Agricultural Engineers' Association by a deputation consisting of Mr. J. H. W. Pawlyn, President of the Association, Sir William Tritton, Mr. Herbert Marshall, and Mr. G. E. Rowland. On the subject of remedial measures the deputation suggested that such questions as the imposition of import duties should be taken out of the region of party politics and investigated by impartial experts. They considered that wise political action might do something to hasten the recovery of the world's purchasing power; at the same time, reduction of costs of production was the first need of the industry, and this was conditional on a substantial reduction in the cost of living. They suggested that the reduction of taxation and consequent relief of industry was also imperative, and was of more importance than National Debt reduction. Those in charge of the industry were endeavouring to bring about a reduction of costs by improvements in methods of production, but such improvements almost invariably meant heavy capital expenditure, and fresh capital was hard to get under present conditions. Overtime restrictions formed a very serious handicap, particularly in view of the seasonal character of the industry, and a more reasonable attitude on the part of the trade unions would be a great help. More whole-hearted co-operation between employers and employed was necessary before success could be expected, and any scheme for this purpose would receive the earnest consideration of the employers represented by the deputation.

The action of the 200 members of the Workers' Union who struck at the Blackwall works of Baldwins, Limited, will, no doubt, be regarded in extreme Labour circles as an example of the "strike tactics" which Moscow believes ought to be generally adopted. The Workers' Union is, if our memory serves, a party to the national negotiations which are proceeding on the wages question. Yet, they ceased work in this instance at a "selected moment" in support of a local demand for an increase of 10*s.* per week. At the time of the stoppage 150 tons of metal was in a molten state in the galvanising baths, and but for the organisation by the manager of an emergency staff, which succeeded in ladling out over 100 tons, the metal would have solidified and ruined the tanks.

The general public, when they hear of incidents of this kind, use other words than "strike tactics" to describe what happened. The practice is not unknown, in other parts of the country, although

most is heard of it in areas where overtime embargoes are in force. Moulders have been known to leave jobs unfinished, and in danger of ruin, when their ordinary day came to an end, and men who have carried on for a little longer rather than involve their employers in serious losses have been fined by their branches for doing so. On the Mersey, a year or two ago, shipwrights stopped before they had completed the docking of a ship—a highly dangerous proceeding, it will be agreed. Other instances in other industries will, no doubt, occur to the minds of readers.

The Ruhr Miners' Unions have decided to give notice to end the agreement with their employers suspending the eight hours' day. The agreement will cease to be operative on January 31 next, and if a stoppage ensues the workers will, presumably, have behind them the full force of the Miners' International. The mineowners are, further, refusing to accept the wage award of the Arbitration Court, which was issued on November 25. This concedes to the men an 8·9 per cent. all-round increase of wages, and the Unions have formally intimated their acceptance of it. The Ministry of Labour may, it is stated, on appeal by the unions, declare the award binding on both parties.

A report of the British Commercial Secretary at Cologne to the Department of Overseas Trade quotes remarkable figures relating to the coal output of the Ruhr. In July, August and September, of 1913, the daily output of 395,821 workers was 364,157 tons; in the corresponding period of 1921 the daily output of 534,607 workers was only 291,439 tons; in the same three months of this year the daily output of 452,735 workers was 328,201 tons. The explanation of this tremendous fluctuation is the difference in working hours. Up to the revolution in 1918 the hours per day were 8½. On November 18, 1918, they were reduced to 8; in April, 1919, to 7½; and in April, 1919, to 7. Last December, however, the hours were increased to 8 per day, with the result that 452,000 miners are now producing considerably more coal than was raised in the 1921 period by 534,000 miners. The survey states that "the re-introduction of the 7-hours' shift would be simply disastrous to the mining industry." Based on the foregoing figures, the output per month would decrease by 925,000 tons, and the loss in one year owing to reduced output would be about 178 million gold marks.

A claim for a wages advance of 7*s.* per week for plumbers employed in shipbuilding at Barrow-in-Furness has been disallowed by the Industrial Court. The decision of the Court was that having "considered all the facts and evidence submitted by the parties, we find that they afford no justification for awarding the plumbers at Barrow an advance out of step with the advances granted to plumbers in other shipyard districts or to other similar classes of workers in shipyard trades, and accordingly we find that the claim submitted to us has not been established."

At York on December 3 the committee appointed by the engineering trade unions to support the application for a wage advance of 20*s.* per week considered the report of the smaller sub-committee specially set up for the purpose of examining the figures originally submitted on behalf of the Engineering and Allied Employers' National Federation by Sir Allan Smith. At the close of the meeting it was stated that further discussion of the matter had been adjourned until December 11 when a full meeting of representatives of the unions would be invited to approve a proposal that a further conference with the employers should be asked for.

A White Paper has been issued giving a statistical summary by the Chief Registrar of Friendly Societies of the operations of registered trade unions in 1922–23. The information is given now in order that the particulars relating to last year may be available as soon as possible, but adjustments may be necessary, it is pointed out, in the Chief Registrar's report for 1923. The figures reflect the falling-off in trade union membership which has been apparent for some time. At the end of 1923 the number of members was 4,413,589; a year earlier it had been 4,559,167; and in December, 1920, 6,981,750. The income of the unions from members was 8,086,802*l.* in 1923, 8,988,822*l.* in 1922, and 11,315,232*l.* in 1920. Allowances from the Ministry of Labour in respect of unemployed insurance, &c., amounted to 312,024*l.* in 1920, 5,448,721*l.* in 1922, and 2,649,364*l.* in 1923, and income from other sources to 1,372,320*l.* in 1920, 1,000,000*l.* in 1922, and 653,281*l.* in 1923. At the end of 1920 the total funds of the organisations was 15,974,799, at the end of 1922 10,008,064*l.*, and at the end of 1923 10,888,505*l.*

NOTES ON NEW BOOKS.

A TREATISE which has reached a fifth edition is its own best advertisement, and this is the case with Professor H. J. Spooner's text-book on "*Machine Design Construction and Drawing*," published by Messrs. Longmans, Green and Co., at 21*s.* net. The work appears to be intended mainly for the ordinary draughtsman, or for apprentices attending evening classes, and for the benefit of the latter the opening chapters give a great deal of useful information on the selection and use of drawing materials and on elementary geometry. The characteristic feature of the remainder of the volume is the great wealth of illustrations of machine and engine details. These are accompanied by clearly written descriptions and much excellent comment. Special attention has been paid to the design of petrol motors. The questions appended to the end of most of the chapters will prove extremely valuable in enabling the student to test his understanding of the text, and in addition to these the volume includes a representative collection of questions taken from papers set in the examinations of the Board of Education and of the City and Guilds Institute.

For preliminary estimating it is frequently more advantageous to have data at hand which, though it may not be absolutely accurate, makes it possible to arrive at comparative figures, so that the relative cost of alternative methods may be studied. Price books and collected data are really most valuable from this point of view, as they enable engineers and others, whose work usually involves the combination of efficiency and economy, to determine the most likely arrangements from which economy in conjunction with satisfactory work might be secured from tenderers. Collected data of this kind, if rightly used, may be very serviceable and they possess additional attraction if presented in handy form. The latter is characteristic of "*The Civil Engineers' Cost Book*," by Colonel T. E. Coleman (Messrs. E. and F. N. Spon, Limited, London; 10*s.* 6*d.* net), the volume of over 300 pages being of the size of a large vest pocket book only. This little work has arrived at a fourth edition in a comparatively short space of time, which alone is proof of the service it renders. In the present edition the whole of the original matter has been re-written and prices have been brought up-to-date. In addition much new matter has been included. The notes cover methods of execution as well as costs, and embrace a very wide range of subject. A list of contents is given at the commencement, but what is of greater value is the fact that the notes are arranged under key words in alphabetical order, which scheme a good index at the back supplements in a very satisfactory manner.

Cadmium is rare in so far as practically only one specific cadmium ore is known, the sulphide or green ockite. As a companion of zinc, lead and also copper, cadmium is found in many ores, and the metallurgy of cadmium is connected with the metallurgies of zinc and lead. That is hardly sufficient reason, however, for opening a book on cadmium with a special page: "Summary of the Metallurgy of Cadmium," and making prominent the statement that cadmium-bearing ores of zinc, &c., have to be treated for the recovery of their principal metal to give by-products, which, on distillation, electrolysis, &c., yield cadmium metal, as Dr. Norman F. Budgen, M.Sc., does in his monograph on "*Cadmium: Its Metallurgy, Properties and Uses*" [London: Charles Griffin and Co., Limited, price 21*s.* net]. The same remark might be made with regard to tellurium and some platinum metals. But Dr. Budgen's book is very welcome as a monograph, probably the first of its kind, on a metal which has so far found little application in spite of many attractive properties. Professor T. Turner, of Birmingham, states in the foreword that he suggested the subject to Dr. Budgen, and that the new research work noticed had been done in his department. Dr. Budgen deals with the metal, its metallurgy, physics and chemistry, its alloys, electro-deposition of cadmium and its alloys, and gives in the last chapter a summary of its uses, which the recent developments of electrolytic zinc, especially in Australia, may help to extend. The book is almost overladen with references, which are mostly numbered, but sometimes mere bibliographical lists, also of value. The one cadmium compound, with which the electrician is perhaps most familiar, the amalgam and its somewhat troublesome behaviour in normal cells, is given only one reference, and that not a recent one. But that is exceptional. Copper-cadmium trolley wires will be quite a novelty to most readers, who will generally be interested in the volume.

When Dr.-Ing. Hans Lorenz, Professor at the Technical High School of Danzig, recently started on the revised edition of his "*Technische Mechanik starrer Gebilde*" [Berlin: Julius Springer; price 4·30 dols.], which forms the first volume of his "*Lehrbuch der Technischen Physik*," he had 20 additional years of experience as lecturer on the subject, and he had become convinced that alterations in and additions to his first edition of 1902 would not meet his object. Whether or not, in deciding completely to rewrite the book, he also reversed the arrangement, we cannot say. At present his chief divisions are: kinematics of plane systems, dynamics of the mass point, statics of plane systems, dynamics of rigid systems. He does not say at all why he deviates from the traditional sequence of statics first and kinetics afterwards. Without giving any definitions, he goes right into the matter; we find gear ratios on page 6 and something akin to Minkowski's "world lines" on page 14. The treatment, insufficiently physical, does not facilitate the study of a noteworthy book, although practical examples are given on many pages and a good index has been provided. On another controversial matter the German colleagues of Professor Lorenz have more to say. Instead of the customary terms for acceleration and deceleration, Beschleunigung and Verzlögerung) he proposes Anlauf and Ablauf; for angular velocity he substitutes Drehwert. Some of his new words have the advantage of shortness, but they can hardly be recommended on other grounds. Professor G. Gehlhoff's "*Lehrbuch der Technischen Physik*" is a very different book and follows more traditional lines, even in the sections on mechanics, which have been contributed by Professor L. Hopf and Th. von Kármán, well known as original workers in the field of aero-dynamics. The first volume of this text-book [Leipzig: Johann Ambrosius Barth; price 17·50 gold marks] covers a wide range, and deals in its main parts with units and measurements, mechanics, acoustics and thermo-dynamics. Professor Gehlhoff himself is director of the Osram Gesellschaft of Berlin. Among his collaborators are Drs. W. Hahnemann and H. Hecht, of the Signalgesellschaft of Kiel, who contribute the sections on acoustics; Dr. W. Meissner, of the Reichsanshalt, who writes on heat and thermo-dynamics; Dr. G. Flügel, of the A.E.G. turbine works, who contributes the section on prime motors working with fluid agents; Dr. R. Becker, who discusses the phenomena of explosion; and Mr. E. Altenkirch, who has taken the sections on refrigeration and liquefaction. Professor Gehlhoff speaks of his compilation as a first attempt to present the general problems of technical physics; conciseness had to be studied, and some points, *e.g.*, the analysis between electricity and acoustics, might profitably have been developed a little further. Measurement by the aid of projection apparatus is not mentioned. The references are limited to books, almost all of quite recent years. The absence of an index is regrettable.

An enormous amount of attention has been given to the question of fixing rates at which electricity should be sold, and in no other business is so much interest taken in devising systems which are supposed to ensure that each class of customer shall pay a sum proportional to the actual cost of serving him. However sound this principle may appear, it is no use putting it into practice if it is prejudicial to the growth and prosperity of the undertaking, as, in certain cases, it may well be. If users of electricity are willing to pay, say, 8*d.* per unit for light, and will not pay more than 1*d.* per unit for power, it is useless to tell them that power should cost more than this in relation to light. All rates must be acceptable ones if the undertaking is to flourish, and no pedantic considerations should prevent any rate being quoted, if its acceptance would be directly or indirectly profitable in the long run. Subject to a realisation of this fact, it is well that the production cost of electricity for different classes of load should be carefully studied and in "*Electricity Supply Costs and Charges*" (London: The Electrical Review, Limited, price 2*s.* 6*d.* net.) Mr. H. M. Sayers, M.I.E.E., has made a very sensible review of the main questions involved. For determining the effect of various loads on the coal consumption, Mr. Sayers has adopted the system of Parsons lines and has drawn the usual deductions, which have several times been pointed out in our columns and elsewhere. He does not mention the origin of this method and clearly has not studied it sufficiently to realise the fact that the Parsons line must of necessity pass through the average point, for in two of his diagrams he has drawn it in a manner which fails to comply with this condition. Furthermore, the method he gives of checking the correct slope of the line provides no check at all, because any line whatever which passes through the average point must fulfil the conditions he prescribes. The best practical check on the position of the line is afforded by the consistency of its equation with those relating to the water consumed and the evaporation obtained. There is also, of course, the exact mathematical

method, from which the fact that the line must pass through the average point follows as a corollary. It is a pity that the author has tripped up in connection with a method upon which his conclusions so largely depend, but the principle remains sound and the method is sufficiently well known to render the error comparatively harmless.

FRENCH NAVAL PLANS.

The French Naval Estimates for 1925, which have now been submitted to the Chamber of Deputies, amount to 1,300 million francs, or approximately 15,500,000*l.* It has been decided, we learn from an article in *The Times*, to carry out naval reconstruction in a period of 20 years, the provisions being based upon the Washington Agreements, which have now been ratified by the French Government. The cost of new construction in 1925 is estimated at 500 million francs, which it is anticipated will be the normal annual expenditure on new ships, including tenders, aeroplane carriers, floating workshops, &c., until, the building of ships of the line is resumed in 1932 as arranged for in the general programme of naval construction, the first part of which was authorised by the law of April 18, 1922. This programme provides for a French High Sea Fleet of 178,000 tons of ships of the line; 360,000 tons of light surface vessels; 65,000 tons of submarines, or 90,000 tons of submarines for coastal defence are included, and about 150,000 tons of vessels for special purposes, such as oil carrying, mine laying, floating workshops, sea plane carrying and the shipment of submarine supplies.

In the estimates that have been made, the serviceable life of ships of the line, seaplane carriers and special boats has been taken as 20 years, while 17 years has been accepted as that for cruisers, 15 years for destroyers and 12 years for submarines. The estimated total cost of new construction over a period of 20 years amounts to about 116,500,000*l.* Some portion of the credits for 1925 is to be allocated for the reorganisation of the shipbuilding yards, which during eight years of idleness have not been kept abreast of the advances made in naval construction. A great sum of money is also to be spent in increasing the pay of the personnel and providing improved conditions. This is essential in order that a steady improvement may be obtained in the number of volunteers. The report calls attention to the urgent need for improvements in the air arm of the French Navy and also for the provision of liquid fuel storage.

Contracts.—Messrs. Vickers, Limited, Barrow-in-Furness, have received an important order for washing trommels for the Rand.—Messrs. Meldrums, Limited, of Temperley, near Manchester, have, during the last three months, supplied furnaces and stokers for 25 boilers of various types, 27 destructors ranging from the small domestic type to the brick-built cell, three sack disinfectors, and 50 units of steam jet apparatus for chemical plant.

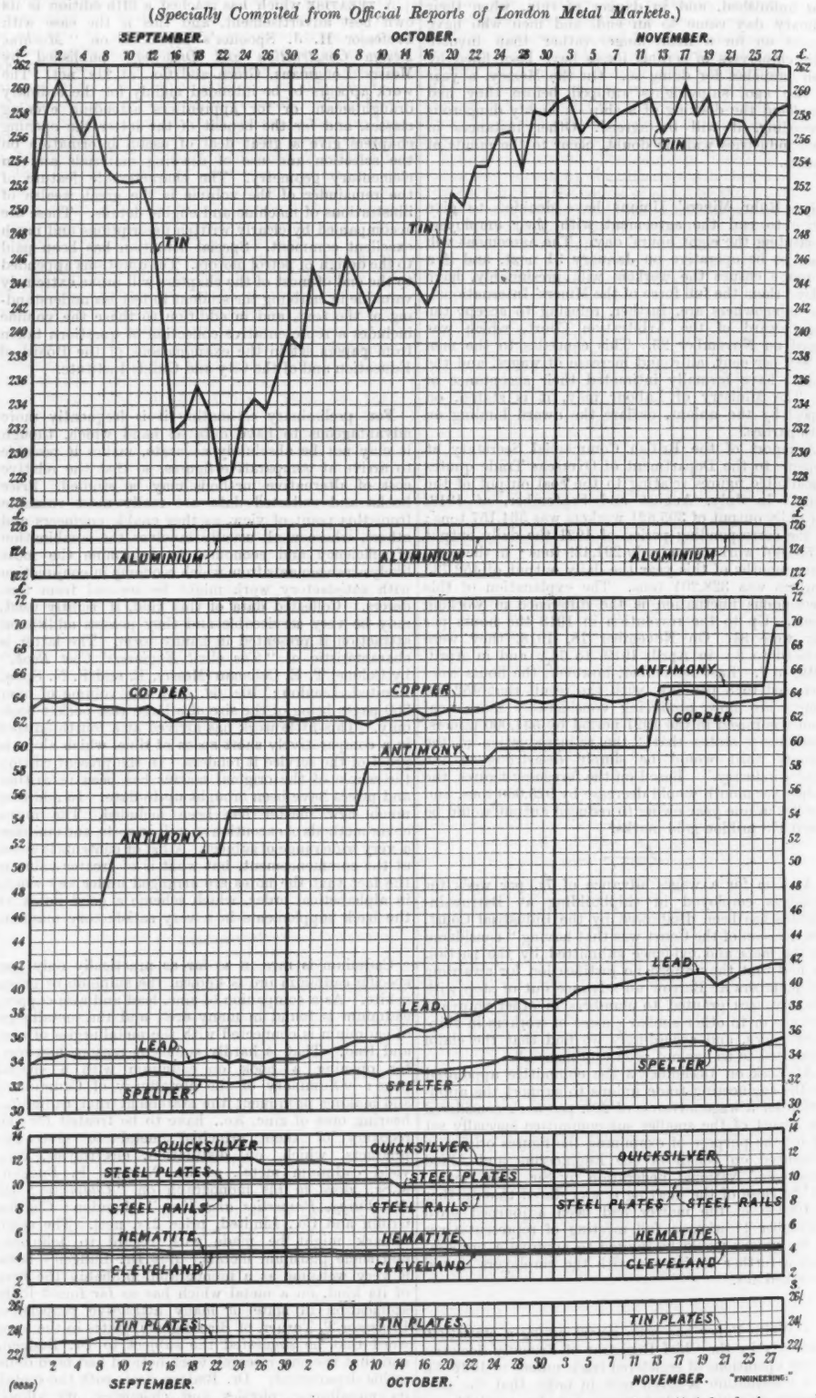
The Late Mr. Thomas McGregor.—We regret to record the death of Mr. Thomas McGregor, of 148, Balgray-hill, Springburn, Glasgow, late Works General Manager of the North British Locomotive Company, Limited. For over half a century Mr. McGregor was associated with the locomotive industry and was held in high esteem by the above-named firm. He retired from work in 1917. Mr. McGregor was 84 years of age at the time of his death.

Jubilee of the Yorkshire College of Science.—The jubilee of the Yorkshire College of Science and the coming of age of the University of Leeds will be celebrated from December 15 to December 20 inclusive. On Monday the 15th inst., the opening ceremony will be held in the Great Hall of the College, while in the afternoon of that day there will be a reception at the Medical School, and in the evening the university dinner will be held at the Town Hall. Somewhat similar ceremonies will take place on the following days, which will include the presentation of congratulatory addresses from universities and learned societies and a conversazione on the evening of the 17th inst.

The Institution of Heating and Ventilating Engineers.—A paper on "Air Washers and Air Filters," by Mr. H. W. S. Martin, was read at a meeting of the Institution of Heating and Ventilating Engineers, held at the Engineers' Club, London, W.C., on the 3rd inst. Mr. Martin stated that in any of our large towns the necessity for washing and filtering the air to cleanse and remove the soot and smoke before passing it into a public building was fully recognised. Possibly very soon, the health authorities would insist on the smoke nuisance being stopped, or at least very greatly mitigated, but until that time came air washers or filtering apparatus in connection with a plenum heating and ventilating plant for a public building were essential. The most desirable conditions for a public building involved humidity for the air. The short dry cough heard repeatedly in a theatre or church was a clear indication that the air was too dry. Taking the lowest winter temperature conditions obtaining in England and the Home Office humidity regulations for cotton factories, which might be regarded as the maximum desirable, the degree of humidity to be aimed at lay between those two extremes. It was the medical man who should determine what was the best standard condition, and then the heating and ventilating engineer should design his apparatus to maintain that condition.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN THE PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal Markets.)



Note.—In the diagrams the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for fine "foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. Middlesbrough prices are plotted for steel plates and rails, and also for hematite and Cleveland pig-iron. The prices given, in the case of steel plates are for ship, bridge and tank qualities, and those for steel rails are for heavy sections. The pig-iron prices are for East Coast hematite and Cleveland iron, both of No. 1 quality and for home consumption. The price of quicksilver is per bottle, the contents of which vary from 70 lb. to 80 lb. The price of tin-plates is per box of I.C. cokes f.o.b. at Welsh ports, but in other cases the prices are per ton. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each.

OIL-ENGINE-DRIVEN ELECTRIC SHUNTING LOCOMOTIVE.

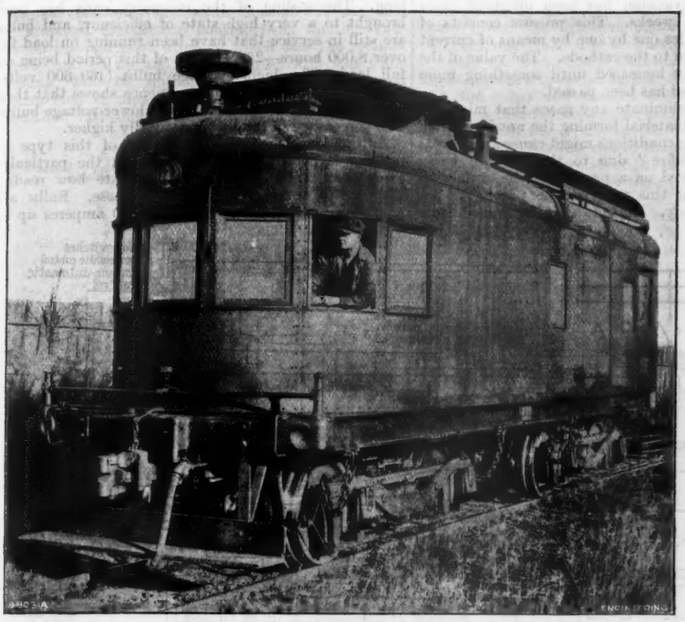


FIG. 1. DRIVING END OF LOCOMOTIVE.

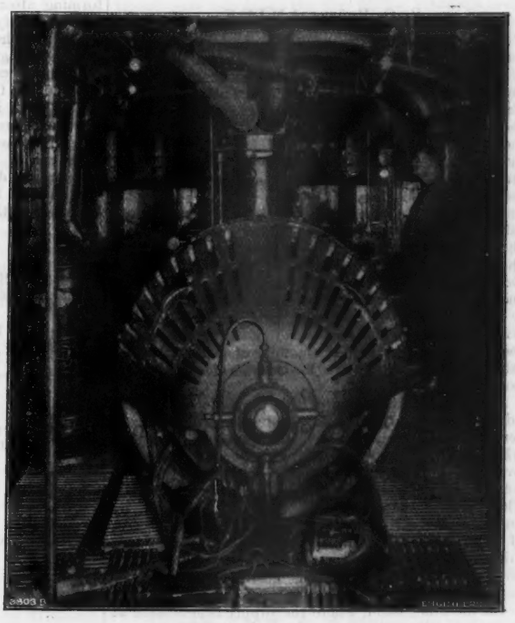


FIG. 2. DIRECT-CURRENT GENERATOR.

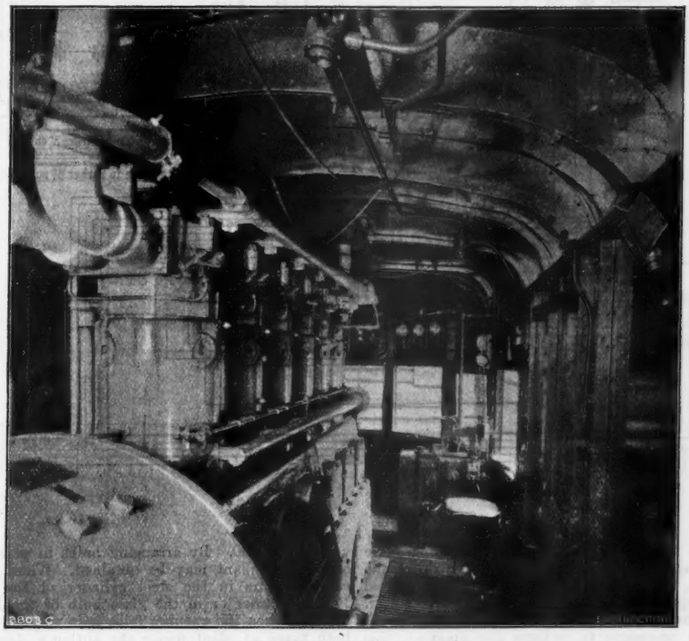


FIG. 3. OIL ENGINE FROM GENERATOR END.

OIL-ENGINE-DRIVEN ELECTRIC SHUNTING LOCOMOTIVE.

AN interesting electric locomotive, the first of its class to be built in America, is illustrated in the figures above. It was built jointly by the General Electric Company, of Schenectady, N.Y., and the Ingersoll-Rand Company, of New York, and has been designed for shunting service.

The machine is equipped with a 300-h.p. oil engine, manufactured by the Ingersoll-Rand Company, directly connected to a 200-kw. General Electric generator. This plant supplies power to four electric motors, one of which is geared to each of the four axles. The unit has a total weight of 60 tons, all on the drivers. The locomotive has been in use in the yards of the Ingersoll-Rand factory at Phillipsburg, New Jersey, for about four months.

The General Electric Company has during the last fifteen years constructed a large number of self-propelled motor-cars and locomotives using petrol as fuel. About 90 equipments have been put into service during this period and most of them are still operating. In order, however, to take advantage of a low-priced fuel in the internal-combustion engine, an arrangement was made with the Ingersoll-Rand Company to build an engine designed for the use of fuel oil and having such characteristics of speed and weight as would make it suitable for use in a locomotive.

The unit which has been constructed is a six-cylinder engine designed to burn fuel oil, and employing the Price system of direct fuel injection. This system avoids the use of high-pressure injection and also effects a reduction in weight, an improvement in mechanical efficiency and an increased simplicity and reliability. The fuel is injected into the various cylinders through a distributor by means of a single-acting plunger-type pump. The lubricating system is of the continuous filtration type, by means of which the oil is returned from the crank-case through an oil filter before being returned to the system again.

All parts of the cylinders, cylinder heads and combustion chambers are water cooled by means of a thermostatically-controlled water supply. The water from these water jackets passes to a radiator located on the roof, and a thermostat maintains an even temperature regardless of weather conditions. Sufficient fuel can be carried for 48 hours' continuous shunting service. A silencer for reducing the noise of the exhaust is also mounted on the roof and, together with the radiator, can be seen in Fig. 1. As ordinarily used in shunting service, this 60-ton locomotive consumes about 0·43 lb. of fuel oil per brake horse-power-hour. Its freedom from smoke makes it especially suitable for service in cities or other places where such visible fumes are objectionable.

An unusual feature of this design is the use of a direct-current generator, supplying current to the motors without intervening accelerating resistances. This is accomplished by using a differential series field on the exciter, which automatically reduces the generator voltage with the increase in the amount of current drawn by the motors. The speed of the locomotive therefore automatically increases as the load is reduced, corresponding to the rise in impressed voltage. This control completely eliminates the possibility of overloading the generator or motors or of stalling the engine. The control is so arranged that the opening of the throttle by moving the control lever increases the engine speed and, at the same time, energises the exciter field, which in turn energises the generator field. The generator current passes through the differentially-wound series field to the driving motors and being opposed to the separately-excited field lowers the generator voltage in proportion to the load. As the locomotive accelerates, the current passing through the differential series field is gradually reduced, the generator voltage automatically increases and speeds up the locomotive. The main excitation of the exciter field is furnished by a storage battery, which also supplies control current and the locomotive lights. A general view of the generator is given in Fig. 2 and of the oil engine in Fig. 3.

LEACHING COPPER ORES.—The Ohio Copper Company are successfully winning copper from beds on the bank of the Birmingham Canyon which contain only 0·3 per cent. of copper. The copper is leached out of the deposit by pumping up the drainage water of the mine to the surface, and then precipitating the copper. The recovery by this method attained 540 tons in the month of June last, and the cost is stated to have been only about half a dollar per lb.

AUTOMATIC AND SEMI-AUTOMATIC MERCURY VAPOUR-RECTIFIER SUB-STATIONS.*

By G. ROGERS, A.M.I.E.E.

Introduction.—Electric supply authorities are being required to give a supply of electricity in their outlying areas for domestic purposes wherever it is demanded. Rapid development is taking place in town planning; building estates are springing up on the outskirts of our large cities, and are often far removed from available sources of supply. Whatever means are adopted to give a supply to these areas, a large capital expenditure has to be faced, the greater part of which is necessarily absorbed in the feeder and distribution mains. Since it is impossible to estimate the ultimate revenue likely to be drawn from the opening up of new districts, it is desirable to keep the initial expenditure down to the minimum. It would not pay to erect and equip a manually-operated sub-station with costly low-tension feeders to supply a large thinly-populated area, and in such cases it will be found necessary to adopt automatic plant requiring the minimum amount of attention and labour, and to eliminate low-tension feeders where possible.

It is outside the scope of this paper to discuss the advantages and disadvantages of alternating current *versus* direct-current supply, but it may be said that where available supplies have a frequency of 40 and over, the problem is simple, as distribution on the four-wire three-phase system is easy, cheap and flexible. The network may be developed where required, by means of static transformer sub-stations, and the cost of a low-tension distributing system can be kept to a minimum. Direct current, however, has distinct advantages over alternating current for domestic supplies for cooking and power purposes.

On the other hand, where the supply is generated at 25 periods, alternating-current supply at this frequency is, in the opinion of the author, unsatisfactory for domestic purposes, and it becomes necessary to convert to direct current or to change the frequency by means of frequency changers. Converting by means of rotary converters or any other form of rotary plant is too expensive for outlying districts, owing to the high costs of labour and the skilled attention required. Automatic rotary-converter sub-station equipments of small capacities will be too expensive. To put down one large automatic rotary-converter sub-station at some central point and feed out to considerable distances by means of low-tension feeders would prove very expensive, owing to the large capital that it would be necessary to sink in copper. The obvious solution is to put down small automatic converting sub-stations at points where the load is required, and to make them as near as possible comparable with the alternating-current distribution mentioned above.

Greater Birmingham had to face the problem described above, and after preliminary investigations and tests the City Electrical Engineer, Mr. R. A. Chattock, decided to develop a system of small automatic sub-stations equipped with mercury-vapour rectifiers of the glass-bulb type. This was a bold course to take, since there were not in existence any similar type of sub-stations designed to give a three-wire direct-current supply. The series of sub-station described later in this paper were the first of their kind to be equipped in this country.

The Principal Features of Mercury-Vapour Rectifiers.—The mercury-arc or mercury-vapour rectifier is an apparatus for transforming, statistically, alternating current into direct current. The different forms of rectifiers now on the market are developments of the small glass-bulb rectifier introduced by Mr. Cooper Hewitt in the United States some 20 years ago.

The non-return valve action of the arc, when operating in a vacuum under certain temperature conditions, allows the current to flow in one direction only, viz., from the anode to the cathode, the cathode bath of mercury being the positive pole of the direct current circuit.† An anode is provided for each phase of the current that is to be rectified. The negative direct current pole is coupled to the star or neutral point of the three-phase alternating-current transformer through a reactance.

Brown-Boveri Rectifier.—This apparatus has been fully described in the technical press and is familiar to most engineers. The vacuum in the steel cylinder is obtained and maintained by means of a special exhaust pump. The extent to which the pump has to be used varies with particular sets. The pump of the set referred to in this paper has to be used only once a week when half load is not exceeded, but above half load it has to be continually in service.

In this type of rectifier, after erection it is necessary for the anodes to be formed, and the operation of forming after the vacuum has been obtained takes approximately two weeks. This process consists of heating up the anodes one by one by means of current passed through them to the cathode. The value of the current is gradually increased until something more than normal full load has been passed.

The effect is to eliminate any gases that might be given off from the material forming the anodes, which gases under working conditions might cause an internal flashover or "backfire" due to the vacuum being temporarily destroyed on a portion of the surface of the anode. During this process, the pump is kept working continuously. Current may be passed from the anodes to the cathode by means of a suitable resistance across the direct current terminals of the rectifier or better still, by means of some external source of supply such as a low-voltage booster. Again, if the set has been out of service for more than 24 hours it is necessary to re-form the anodes; this operation takes about half an hour and must be done by manual operation. This is a drawback to this pattern of rectifier, which otherwise lends itself admirably to a simple form of automatic control.

Water cooling is adopted for the anodes and for the main cylinder, and this method is quite efficient; 70 gallons of water per hour are required for the set described in the paper. The apparatus has been found to be reliable in operation, and the maintenance costs are low. Cylinders are now built each capable of giving up to 900 amperes (direct current) at 600 volts.

Hewittic Rectifier.—This rectifier is of the glass-bulb type, the vacuum being permanent. Fan cooling is adopted, the fan being placed under the bulb and blowing air across it. No special forming has to be done after delivery. Bulbs may readily be put into service almost immediately on completion of erection. Also, no forming is subsequently required, however long the bulb has been out of service. This is a very useful feature.

The lower-voltage glass bulbs have a much better life than one would expect. Provided a bulb survives transit—and very few are damaged—and proves satisfactory in service for a few days, its life is extremely long. The sealing of the incoming leads has been brought to a very high state of efficiency, and bulbs are still in service that have been running on load for over 8,000 hours—25 per cent. of this period being on full load. The higher-voltage bulbs (460–600 volts) also give long service, but experience shows that they do not have such a long life as the lower-voltage bulbs. The percentage of failures is naturally higher.

Automatic operation and control of this type of rectifier is comparatively simple, and the particular cases dealt with in the paper indicate how readily they adapt themselves to this purpose. Bulbs are now made each capable of giving 150 amperes up to voltages of 600. By arranging bulbs in parallel any capacity of plant may be obtained. When a short-circuit occurs in the steel cylinder of the Brown-Boveri rectifier or in the glass bulb of the Hewittic rectifier when the vacuum fails, it is very severe. In both types of plant under the author's observation, however, short-circuits have been few in number, and in the case of the glass bulbs for 230 volts no single instance of a short-circuit has occurred.

Automatic Operation and Control, of a 220-kw. Brown-Boveri Rectifier Working in Parallel with a Three-wire Battery for Balancing Purposes.—This type of mercury rectifier has been fully described in the electrical press.* This set was first installed for manual operation, but later was equipped for automatic control. It is connected to a 5,000-volt, three-phase, 25-period supply, and gives direct current at 460 volts across the outers of a three-wire network. Fig. 1 is a complete wiring diagram of the automatic arrangements developed step by step until the necessary control was completed. The rectifier has been running now with this control for over two years, and no trouble whatever has been experienced with the set.

It will be seen that by means of selector switches the

Fig. 1.

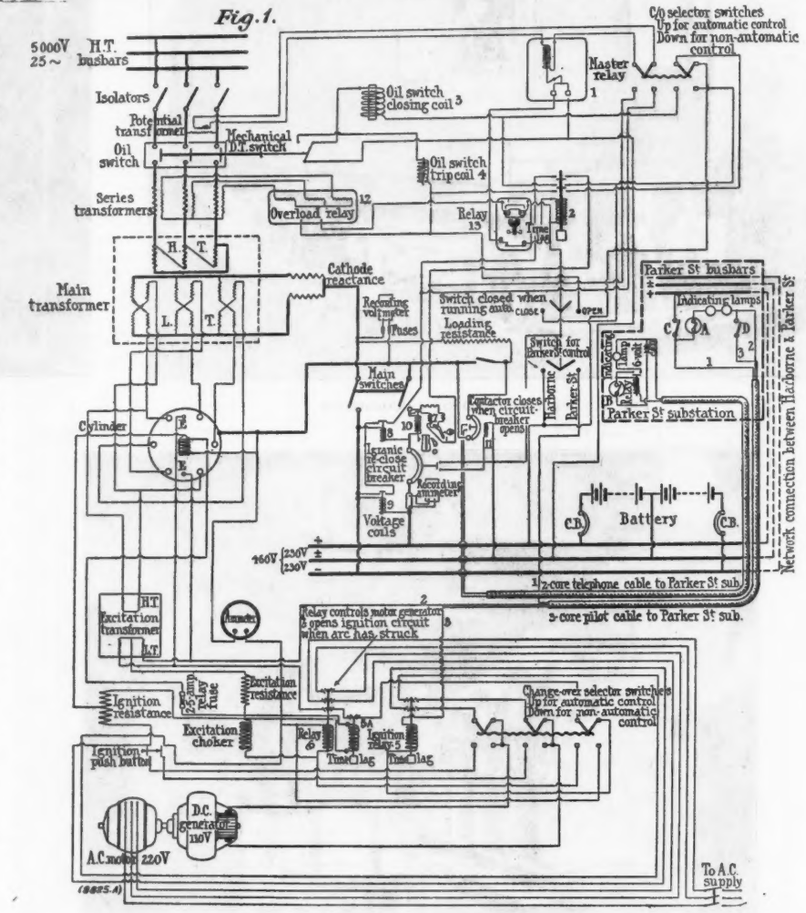


FIG. 1.

* Abstract of paper read before the Institution of Electrical Engineers in London, on November 20.

† For further particulars, see *Electrical Review*, 1921, vol. lxxxviii, pp. 217 and 251, and ENGINEERING, 1923, vol. cxvi, pp. 507 and 543.

* *Loc. cit.*

rectifier can be left running continuously on the system and, under these conditions, will be automatically disconnected from the busbars, in the event of a fault or a failure of the e.h.t. supply and restarted as soon as conditions are again normal. It can also be arranged for remote control from another sub-station through pilot wires, in which case the rectifier can be started up and shut down at will, and while running will be automatically disconnected and reconnected in case a fault develops, as in the first condition. By the simple addition of a voltage relay and a minimum-current relay, or by the addition of time switches, the set can be made entirely automatic in its operation.

FIG. 2. MAP OF GREATER BIRMINGHAM, SHOWING POSITION OF RECTIFIER SUB-STATIONS.

The operation of the control gear is as follows, the action of the relays being described in their proper sequence of operation :—(1) A master relay switch operated by the secondary of a potential transformer, which when energized closes the circuit operating relay (2) and, when de-energized due to failure of the alternating-current supply, clears the set from the alternating-current and direct-current busbars. (2) A time-limit relay which, when energized, closes contacts operating oil-switch-closing solenoid (3) and, when de-energized, closes contacts which operate oil-switch-tripping solenoid (4). An interlock on this relay prevents the direct-current breaker from being closed or remaining closed when this relay is de-energized. Immediately the oil switch closes, the pump and the ignition converter start up. (5) The ignition relay which, when energized through interlocks on relays (5A) and (6), closes the ignition arc circuit. The action of this relay is delayed 10 seconds to allow the ignition motor-generator to become fully excited. (5A) If the ignition arc fails to strike, this relay comes into operation and de-energizes (5), when the operation is repeated with an "in and out" movement until ignition is obtained.

(6) The coil of this relay is in series with the excitation circuit and operates immediately the ignition arc has been struck by relay (5). When energized, the relay shuts down the ignition motor-generator and de-energizes relay (5). The rectifier, after this operation, is ready for load on the direct-current side, and the direct-current breaker (an Igranic reclose circuit breaker) will now close and parallel the set to the busbars providing that the voltage across the rectifier terminals is correct and the direct-current busbar voltage is not too high. The closing coil of the direct-current circuit breaker is connected through an interlock on relay (2) and is also controlled by the adjustable voltage coils (7), (8) and (9).

(10) A series coil which opens the direct-current circuit breaker on overload. The operation of this coil is limited to three times, after which it remains open until reset by hand. (11) A contactor which closes the loading-resistance circuit when the direct-current breaker opens. (12) A three-phase inverse time-limit overload relay, the operation of which shuts down the set. (13) A relay which is operated by the action of relay (12) and prevents the oil switch being closed until reset by hand.

For remote control, the supply to relay (2) is provided by means of one core of a pilot cable through a control switch, and the coil circuit of ignition relay (5) is looped through pilot wires to a switch at the control sub-station.

The lamps shown on the control sub-station end clearly indicate :—(1) When the oil switch closes or opens. (2) When the excitation arc is struck.

The opening or closing of the direct-current circuit breaker is indicated by the low-voltage lamp connected to two cores of a telephone cable.

Small Automatic Three-wire Rectifier Sub-stations for Outlying Areas, Housing Schemes, &c.—Fig. 2 shows an outline map of the Birmingham area, indicating the position of the generating stations, the existing manually-operated rotary-converter sub-stations and the position of the rectifier sub-stations in the outlying areas, each having its own distributing network.

These outlying areas are comparatively thinly populated. A 5,000-volt three-phase ring main passes through this area, looping into the various sub-stations. Connections have also been made to other existing ring mains in the area.

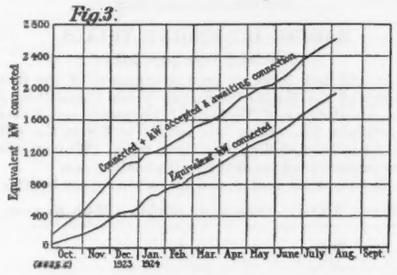


FIG. 3. CURVES SHOWING PROGRESS OF DEMAND (MOSTLY DOMESTIC LOAD) IN NEW DISTRICTS OPENED UP BY MEANS OF RECTIFIER SUB-STATIONS.

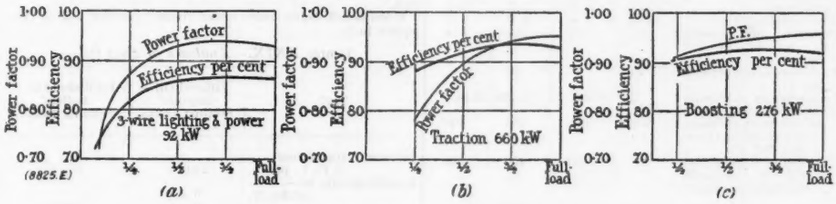


FIG. 5. CURVES OF POWER FACTOR AND EFFICIENCY TAKEN FROM TESTS.

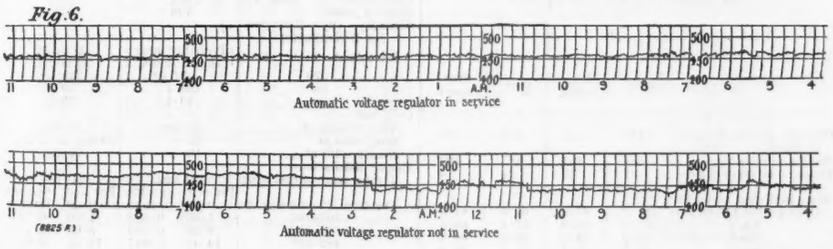


FIG. 6.

It was decided to commence operations with a three-wire unit, having a capacity of 46 kw., the transformer supplying the two 23 kw. rectifiers being designed for an ultimate load of 92 kw. Two 100-ampere 230-volt bulbs were connected in series across the outers of the three-wire network, the neutral or third wire being connected between them; and later, by the addition of two further bulbs of the same capacity in parallel, the unit was brought up to its full capacity of 92 kw.

Certain of these sub-stations have already been brought up to the 92 kw. capacity, owing to the rapid growth of the demand in these areas. Fig. 3 shows this development over a period of 12 months.

Provision is made in each case for an extension to the building when necessary. It is proposed to install in the extension a unit having a capacity of 138 kw., making the total capacity of each of the small sub-stations 230 kw. This extra capacity has now been added in several cases and is likely to be enough for any particular area. When the full capacity of the station has been reached, it is intended to develop areas in the district by means of further similar sub-stations.

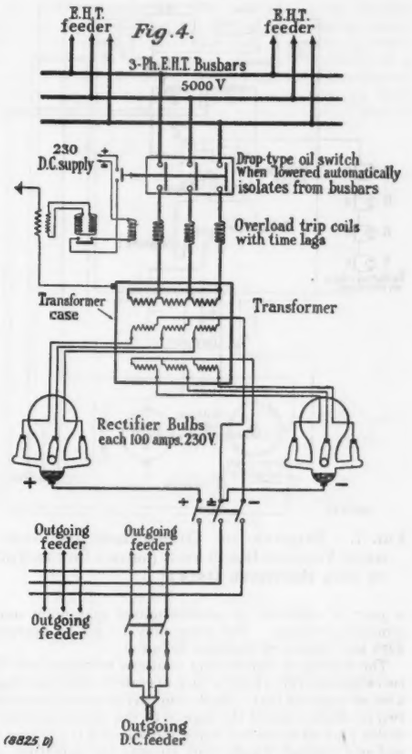


FIG. 4. DIAGRAM OF CONNECTIONS OF 46-KW. THREE-WIRE LIGHTING AND POWER RECTIFIER SUB-STATION.

Fig. 4 shows the general electrical connections in a complete sub-station, but does not include the internal arrangements of the rectifier. It will be seen that the high-tension feeder is looped into the sub-station, the oil switches being non-automatic in operation. The transformers, on the other hand, are protected by overload coils in each phase. Leakage protection is also provided by means of a current transformer in the "earth" connection of the transformer tank. A leakage of 2 to 3 amperes of earth is sufficient to cause the main oil switch to open. The current passing through the current transformer operates a special relay, which, in turn, closes the trip circuit energised from the 230-volt circuit.

The rectifier itself is equipped with automatic gear which, in the event of a failure of the alternating-current supply, will strike the ignition arc in the bulbs when this is restored, and resume the supply to the external direct-current circuit. No automatic switchgear is provided on the direct-current side. Each connection to the distributing network is protected by means of fuses. It may be necessary later to equip each of the rectifiers with a reclose overload circuit breaker, but up to the present it has not been found necessary on the small sets. The efficiency and power factor of a

92-kw. three-wire rectifier equipment are shown in Fig. 5 (*a*).

The direct-current voltage of a mercury-vapour rectifier is directly proportional to the alternating-current voltage supplied to the anodes of the bulb. It follows, therefore, that in addition to the voltage drop of approximately 5 per cent. from no load to full load, there may be variations due to the variations in the alternating-current pressure. If, as in this particular case, the ring-main feeder is fed from the same feeders that supply large power consumers, such variations may be fairly large. To meet this, an arrangement has been developed to operate the voltage regulator automatically. The rectifiers are provided with a regulating transformer with a number of tappings, and by means of sliding contacts the voltage of the supply to the anodes may be varied.

Fig. 6 is a facsimile of two voltage charts, one with no regulation and the other with the automatic voltage regulator in service. The electrical connections for the complete automatic control of the voltage regulator are shown in Fig. 7.

The operation of the automatic regulator gear is as follows :—A voltage relay (1) connected across the direct-current terminals of the rectifier closes either of

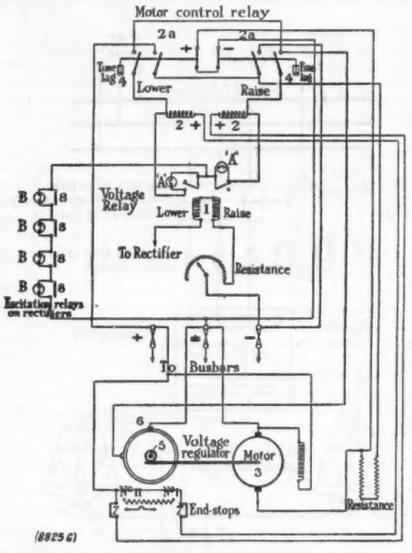


FIG. 7. DIAGRAM OF CONNECTIONS OF AUTOMATIC VOLTAGE REGULATOR (SHOWN CONNECTED TO ONE RECTIFIER ONLY).

a pair of contacts at predetermined maximum and minimum voltage. The relay may be set to operate with any degree of closeness required.

The closing of either relay contacts energises one of two solenoids (2), which in turn operate an arm carrying a set of contacts (2*a*). Each arm carries three contacts, two of which control the supply to the small operating motor (3) and are closed when the solenoid is energised, and one contact which short circuits the armature of the motor when the solenoid is de-energised. The two solenoids are mechanically interlocked so that only one can operate at a time.

Each arm is also equipped with a time-lag (4), which prevents the operation of the motor due to a momentary change in voltage. The operation of one solenoid causes the motor to revolve in the forward direction, and the operation of the other solenoid causes the motor to revolve in the reverse direction.

The motor shaft is connected directly to the operating spindle (5) of the regulator by means of worm reduction gearing. After either of the solenoids has been energised by the voltage relay, the motor continues to revolve until one complete revolution of the regulator spindle has been completed, whether the contact of the voltage relay (1) has opened circuit or not. At the end of each complete revolution the motor armature circuit is opened by means of a contact (6) on the spindle. If the contact of the voltage relay is still further closed, the motor will continue to make further revolutions, raising or lowering the direct-current voltage until the said contacts break the circuit.

End-stop switches (7) open the motor circuit by de-energising solenoid (2) at the end of the travel to prevent over-running. The supply to the motor is so interlocked with the excitation relay (8) of each rectifier bulb that a failure of alternating-current pressure or a failure of any one bulb opens the motor circuit.

Switches (A) are provided in the voltage relay circuits to allow of the operation of the regulator independently of the voltage relay, and switches (B) are also provided in the excitation relay circuit to close the interlock on any one bulb or pair of bulbs if not in service.

Suitable resistances are provided in the relay and operating motor circuits.

No attempt is made to balance the voltage of the two sides, care being taken to balance the external load as nearly as possible. It would be possible, however, to arrange for independent voltage regulation of the two halves of the three-wire set. Some 15 of these sub-stations have now been put into service and the total kilowatt capacity of the plant installed is approximately 1,850 kw.

Provision is made for earthing the neutral of the three-wire system at each of the sub-stations. In practice two or more sub-stations are in parallel through the network, the networks being connected solid on the neutral and through fuses on the outers.

(To be continued.)

MARINE OIL-ENGINE TRIALS.

(Concluded from page 753.)

IN our last issue we gave a summary of the first report of the Marine Oil-Engine Trials Committee of the Institutions of Mechanical Engineers and Naval Architects, &c., taking the subject as far as the end of the sections dealing with shore trials. We continue the summary below, dealing with trials at sea.

The sea trials were carried out on the voyage between Swansea Docks and the Mersey estuary on April 11 and 12, 1924. "On leaving Swansea the vessel had on board 3,000 tons of general cargo, which precluded the possibility of making any runs upon the measured mile. The following is an estimate, furnished by the owners, of the weights carried :—Cargo, 3,140 tons ; fuel, stores and water, 615 tons. Total, 3,755 tons. In this condition of load the draught was 17·4 ft. forward and 20·8 ft. aft." For the fuel consumption trials the engine speed was maintained at full speed (125 r.p.m.) and normal service speed (105 r.p.m.). For the trial at full revolutions the ship speed varied from 11·6 to 12·2 knots. For the trial at reduced revolutions it was between 10·2 and 10·3 knots. The running conditions for the main engines are given in Table XXIII. Deductions from indicator cards taken are given in Table XXV for the main engines, and in Table XXVI for the air compressor.

Tables XXVIII and XXIX give, respectively, the fuel consumption and the analysis of the fuel oil.

"Observations of the lubrication of the main

TABLE XXIII.—*Running Conditions—Main Engines.*

Trial.	I.		II.	
Engine.	Port.	Starboard.	Port.	Starboard.
Time of first observation	2.03 p.m.		8.50 p.m.	
,, last ,,	6.03 p.m.		11.50 p.m.	
Average r.p.m.	127·0	124·8	106·4	104·4
Fuel notch	21·0	24·9	15·1	18·6
Manœuvring dial ..	4·0	4·0	4·0	4·0
Injection air-pressure lb. per sq. in. (by gauge)	933	970	864	914
Engine-room temperature deg. F.	74	—	80	—
Barometer, in. of Mercury	29·66 in.		29·66 in.	
Temp. of exhaust gases :				
At exit from cylinders by pyrometer (average), deg. F.	570	602	383	403
At end of exhaust manifold by mercurial thermometer, deg. F.	643	714	450	504

TABLE XXV.—*Indicator Cards and Deductions.*

(All Pressures in Lb. Per Sq. In.)

Trial.	I.		II.	
Engine.	Port.	Starboard.	Port.	Starboard.
Pressure at end of compression.	456	445	453	443
Maximum pressure ..	482	493	486	499
Pressure at end of expansion.	34	36	24	25
Mean indicated pressure :				
Cylinder No. 1 (forward)	85·2	97·8	67·9	81·9
,, No. 2 ,,	87·2	89·9	67·4	68·3
,, No. 3 ,,	85·9	94·2	68·5	68·7
,, No. 4 ,,	84·5	93·4	61·7	73·9
,, No. 5 ,,	89·2	97·0	68·4	73·6
,, No. 6 (aft)	83·9	102·3	64·2	78·5
Average M.I.P.	86·0	95·8	66·3	74·1
Indicated horse-power ..	1,486	1,627	960	1,053
Total indicated horse-power	3,113		2,013	
Mechanical efficiency from Fig. 25. Per cent.	74·0	77·5	66·5	69·5
Shaft horse-power ..	1,100	1,260	638	733
Equivalent torque, lb. ft.	45,500	52,900	31,500	36,800
Torque from Fig. 26 lb. ft.	45,700	52,900	31,800	37,100
*Deduced mechanical efficiency of engines at sea per cent.	74·5	77·0	63·0	65·4

* Deduced mechanical efficiency of engines at sea—

$$= \frac{2 \times \pi \times \text{R.P.M.} \times \text{torque from characteristic diagram}}{33{,}000 \times \text{I.H.P.}}$$

TABLE XXVI.—*Observations at Injection-Air Compressors.*

Trial.	I.		II.	
Engine.	Port.	Starboard.	Port.	Starboard.
Pressures from Indicator Cards (lb. per sq. in.) at—				
Low pressure suction ..	−7·8	−7·2	−6·2	−4·8
,, ,, Delivery ..	40·4	45·5	44·3	54·0
Middle pressure suction ..	27·6	35·1	34·0	44·2
,, ,, delivery ..	209·3	214·5	218·5	231·6
High pressure suction ..	204·8	207·8	213·8	226·7
,, ,, delivery ..	1,018·5	1,019·7	959·2	962·7
Indicated M.E.P. (lb. per sq. in.)—				
Low pressure stage ..	18·1	18·1	20·8	22·9
Middle pressure stage ..	84·7	77·3	91·4	87·4
High pressure stage ..	355·0	320·1	345·5	320·0
Horse-power absorbed in compressor (I.H.P.) ..	92·8	86·4	82·6	81·0

TABLE XXVIII.—*Fuel Consumption—Main Engines and Auxiliaries.*

Trial.	I.		II.	
	Lb. per hr.	Tons per day.	Lb. per hr.	Tons per day.
Main engines together ..	1,061	11·36	630	6·76
Generator engine	—	0·30	—	0·31
Auxiliary boiler	—	2·20*	—	2·20†
Total fuel tons per day ..	—	13·86	—	9·27

* Port boiler only under steam, pressure 113 lb. per square inch.

† Starboard boiler only under steam, pressure 117 lb. per square inch.

TABLE XXIX.—*Analyses of Fuel Oil.*

Test.	Filtered Oil—Engines' Settling Tanks.		Unfiltered Oil—Boilers' Settling Tanks.	
Calorific value (gross) B.Th.U. per lb.	19,080		19,110	
Specific gravity at—				
50 deg. F.	0·898		—	
59 ,,	0·894		0·893	
68 ,,	0·890		0·889	
86 ,,	0·882		0·882	
Flash point .. deg. F.	174		172	
Burning point ,,	196		178	
Viscosity (by Redwood No. 2 viscometer)—				
Seconds at 32 deg. F. ..	Probably more than 2 hours.		At least 1½ hours.	
70 ,, ..	397·0*		233·0*	
150 ,, ..	53·1		50·7	
200 ,, ..	40·1		39·3	
Cold test—				
Very viscous at	32 deg.		32 deg.	
Semi-solid at	23 ,,		28 deg. to 23 deg.	
Nearly solid at	10 ,,		14 deg.	
Engler distillation—				
Temperature of first drop	254 deg.		219 deg.	
	Per cent.	Specific Gravity.	Per cent.	Specific Gravity.
Fraction 32–302 deg. F.	0·29†		0·30	
302–392 ,,	1·50†	0·882	1·30	0·765
392–482 ,,	8·30	0·769	8·00	0·777
482–572 ,,	14·42	0·847	13·35	0·845
572–662 ,,	45·98	0·842	31·80	0·843
Residue	27·08	—	44·20	—
Loss	2·43	—	1·05	—
Water content per cent.	0·22		0·03	
Ultimate analysis, per cent.				
Carbon	85·42		86·02	
Hydrogen	12·62		12·94	
Nitrogen	0·08		0·13	
Sulphur	1·09		0·97	
Oxygen	0·79		0·06	
Impurities	Slight sediment including black specks.		Slight, fine, light-coloured sediment.	
Carbon residue and free carbon	3·80		2·82	
Ash .. .. per cent.	0·01		0·03	
Soft Asphaltum ,,	1·40		1·37	
Hard asphaltum ,,	0·45		0·36	

* The values at 70 deg. F. represent concordant figures, but as a true estimation they are unsatisfactory, inasmuch as there were stoppages in the flow, due to threads, &c., in the sample.

† The fraction 32–302 deg. F. is low, and the fraction 302–392 deg. F. is high, as the water did not fall into the cylinder until late. The error due to this may amount to about 0·2 per cent.

engines showed that the delivery of the forced lubrication pump was 5,330 gallons per hour at a pressure of 17 lb. per square inch; the supply of oil to all the power cylinders was 12½ gallons per day and to the air compressors 2¾ gallons per day, when the engines were running at 125 r.p.m." After the tests on shore additional lubricators had been fitted.

Two methods are available for estimating the torque from the main engine data: "(1) By means of the i.h.p., using a value for the mechanical efficiency read off from Fig. 25. Torques calculated on this basis are shown at the foot of Table XXV, as are also those obtained by reading off Fig. 26. (2) By the use of the characteristic diagram, Fig. 21."

Fig. 28 shows the rate of oil consumption to be proportional to the power developed, while Fig. 31 shows it to be within the limits of observation a linear function of the exhaust gas temperature. Calculating on both these bases and averaging, the following figures are obtained for fuel consumption reduced to pounds per minute:—

	Trial I.	Trial II.
Port engine	8·42	4·97
Starboard engine	9·28	5·54

"Referring now to the characteristic diagram, Fig. 21, the torque corresponding to each oil consumption at the respective engine speed, may be read directly, and the results are given below:—

Engine.	Trial I.	Trial II.
	Torque—Lb. Ft.	Torque—Lb. Ft.
Port	45,700	29,800
Starboard	52,600	34,700

"The torques read off the characteristic diagram agree fairly with those calculated from the indicated horse-powers developed, as can be seen from Table XXV; a result which shows that the shore trials can be assumed to give a fair indication of the mechanical efficiency of the engines at sea in fine weather. The difference between the torques computed from the above observations in the engine-room and those calculated from readings of the torsionmeters (Table XXX) is due to the friction loss, in the thrust-block and at the shaft bearings, between the engine and the points where the torsionmeters were situated; also to experimental errors and to departure in mechanical efficiency of the starboard engine from that of the port engine.

"Between the 'Moullin' torsionmeter on the port shaft and the engine there were four shaft bearings, in addition to the thrust-bearing, and between the 'Hopkinson-Thring' torsionmeter on the starboard shaft and the engine there were three shaft bearings in addition to the thrust-bearing. Between the above instruments and the propeller there were two and three shaft bearings respectively. The mean values of the torque and the percentage fluctuations from the mean are recorded for both shafts in Table XXX. To determine the mean torque on the port shaft the observed torques were plotted on a time-base and the mean ordinate taken.

"The thrust was measured on the starboard shaft only. The gear which was purchased from Messrs. Michell Bearings, Limited, to suit an ordinary horse-shoe type thrust block, with which the vessel is fitted, is illustrated in Figs. 41 and consists essentially of a pair of yokes connected rigidly together by a pair of steel tie-rods, arranged longitudinally, one on each side of the thrust-block. The yoke at the aft end of the thrust-block was solid, that at the forward end being provided with two cylinders containing oil and in communication with a hydraulic pressure system. The cylinders, which were arranged to be opposite the ends of the long bolts upon which the horse-shoe collars are carried, were each provided with a ram suitably packed to resist high pressures. The pressure was generated by means of a small hand-pump; and a screw-down, non-return valve was provided between the pump and the cylinders in the forward yoke. To use the apparatus, the pressure in the hydraulic system was raised until the rams pressed against the ends of the long bolts. The locking nuts on each side of the bearing lugs were then eased away, thereby transferring the thrust from the lugs on to the rams and the fluid in the system behind them. The movement allowed was 0·02 in. each way, but this movement was not found necessary, and the thrust measurements were taken with the shaft in its correct position. The pressure in the system was measured by the elongation of a spiral spring actuated by a plunger in a small cylinder connected with the pressure system, and was recorded on a strip of paper moved by clockwork. The pressure was automatically recorded together with time in ¼ seconds, and a further pen gave a contact mark when a particular propeller blade was vertical.

"A continuous record of the pressure in the hydraulic system was taken for short periods, and from these the total thrusts are obtained. The position of the cranks at any part of the thrust diagram can be located from these records.

"Typical curves of the variation of thrust throughout a revolution are shown in Fig. 42A, and values of $\frac{\text{Thrust}}{\text{Revolutions}^2}$ or $\left(\frac{T}{N^2}\right)$ plotted to a base of revolutions per minute are shown in Fig. 42B. The thrust associated with the mean speed and revolutions, for the

TABLE XXX.—DEDUCTIONS FROM THRUST AND TORSIONMETER OBSERVATIONS.

Trial.	I.			II.		
Shaft.	Port.	Starboard.	Total.	Port.	Starboard.	Total.
Mean speed, knots .. .. .. (V)		11·90			10·26	
Mean revolutions per minute .. .. (N)	127·0	124·8	—	106·4	104·4	—
$\frac{V \times 101\frac{1}{4}}{PN}$ from trial	0·90	0·916	—	0·927	0·945	—
Thrust in pounds .. .. .. (T)	—	23,550	—	—	16,480	—
$\frac{T}{V^2}$	—	161·9	—	—	152·3	—
Steady variation of thrust from mean value, per cent.	—	16	—	—	30	—
Steady variation of torque from mean value per cent.	+ 6 − 9	+ 5 − 15	—	+ 21 − 24	+ 24 − 34	—
(a) Torque from thrust measurement and screw efficiency	47,100	44,600	91,700	34,200	32,200	66,400
(b) Torque from model resistance and model screw efficiency	39,900	37,900	77,800	26,850	25,600	52,450
(c) Torque by measurement at after end of shaft	37,640	40,870	78,510	24,170	27,040	51,210
(d) Torque from characteristic diagram ..	45,500	52,600	98,100	29,800	34,700	64,500
(e) Torque from indicator cards and mechanical efficiency from shore trials	45,700	52,900	98,600	31,700	37,200	68,900

Fig. 41. ARRANGEMENT OF THRUST MEASURING GEAR. (MICHELL)

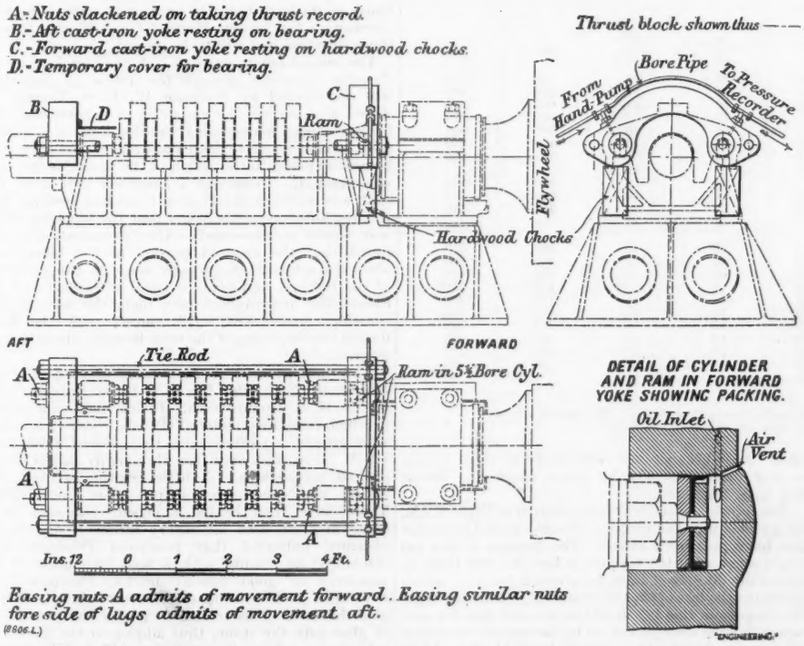


Fig. 42A. CURVES OF VARIATION OF THRUST FOR ONE REVOLUTION.

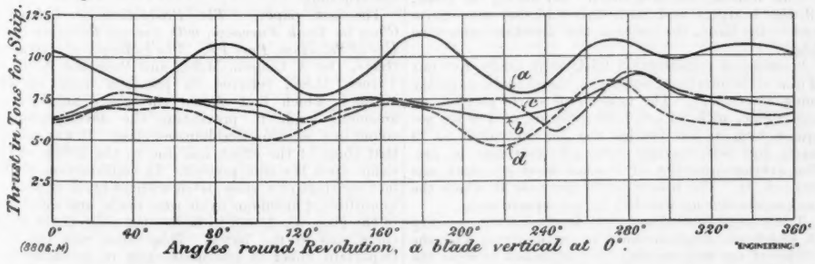
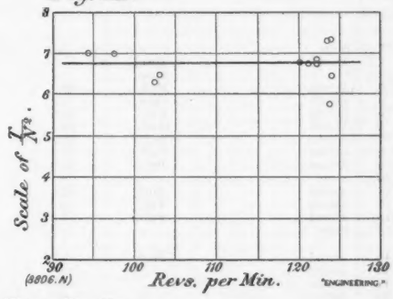


Fig. 42B.



Note to Fig. 42A—

a. One revolution taken at 123 r.p.m.
b., *c.* Two consecutive revolutions at 107 r.p.m.
d. Revolution taken at 96 r.p.m.

Note to Fig. 42B—

Curve of $\frac{\text{thrust}}{(\text{r.p.m.})^2}$ to base of revolutions

"T" in tons, "N" in units of 100 r.p.m.

period of each trial, was calculated from the mean curve of Fig. 42B, at the correct revolutions for each trial. The variation of $\left(\frac{T}{N^2}\right)$ is believed to be due to:—

(*a*) Some variation of thrust due to change of resistance when pitching.

(*b*) Variation of revolutions due to different causes, the revolutions used in the plottings being those for the short period of measurement and not the mean for any long period.

"At low speeds there are three fluctuations per revolution, which, owing to the inertia of the fly-wheel, &c., gradually diminish in relative importance as the r.p.m. increase, but the variations due to the propeller blades passing the hull gradually increase, and are predominant at the full revolutions. The percentage variations from mean thrust are given in Table XXX. As the pitches of the propellers when measured were found to be exactly the same, the thrusts on the port shaft have been obtained from those on the starboard shaft, by assuming that the thrusts on the model and on the ship will vary in the same ratio for small changes of slip.

"A model of the ship was tested in the 'William Froude' National Tank, at a displacement of 9,400 tons, and the propellers were also tried under that revolutions per minute. In order to bring the starboard shaft $\frac{T}{V^2}$ values on to the curve of $\frac{T}{V^2}$ derived from the model, at the $\frac{V}{PN}$ values obtained from the ship, the wake fraction has to be varied from 0·19 in the model to 0·23 and 0·26 for Trial I and Trial II respectively; that is, the ship wake velocity is some 4 to 6 per cent. slower than the model wake. Taking the thrust measurement to be correct and using a wake factor of 0·25, associated with the screw efficiency of the model screws, the torques required to turn the two screws, for each trial, are given in line (*a*) of Table XXX.

"A further estimate of torque can be obtained from the effective horse-power deduced from the model experiments if the model wake and quasi-propulsive efficiency are adopted. The hull resistance has been taken as 17 per cent. and 11 per cent., respectively, for Trials I and II, above the resistance obtained from the naked model to take account of appendage resistance, &c. On this basis the torques required in the shafts are given in line (*b*) of Table XXX. The distribution of this power between the two shafts has been made on the basis of the power which two similar screws would deliver when the revolutions of one exceed those of the other, as was the case in these

TABLE XXXII.—Manœuvring Trial.

No.	Order on Telegraph. Direction.	Speed.	R.P.M. on Tachometer.	Time of Receipt of Order.	Time to carry out the manœuvre (seconds). Port Engine.	Starboard Engine.	Pressure in Starting Air Bottles (lb. per square inch). Before Order	After Order.
				h. m. s.				
1	Stop	—	—	8 33 46	8	12	—	—
2	Ahead	Dead Slow.	60	34 3	7	9	520	475
3	Astern	Full.	100	34 20	33	28	480	448
4	Ahead	Slow.	85	34 58	17	17	455	420
5	Astern	Full.	100	35 24	16	23	425	390
6	Ahead	Half.	105	35 51	37	37	405	375
7	Astern	Full.	100	36 33	19	20	387	360
8	Ahead	Full.	125	36 58	24	24	370	350
9	Astern	Full.	100	37 28	16	16	360	330
10	Stop	—	—	37 48	10	12	—	—
11	Ahead	Full.	125	38 5	20	13	340	325
12	Astern	Full.	100	39 28	24	20	360	312
13	Ahead	Full.	125	40 56	22	27	362	310
14	Stop	—	—	41 28	10	12	—	—
15	Ahead	Slow.	85	41 45	13	13	330	310
16	Astern	,,	60	42 18	19	19	325	295
17	Ahead	,,	85	42 48	19	17	312	270
18	Astern	,,	60	43 18	16	25*	240*	210*
19	Ahead	,,	85	43 50	15	15	425	380
20	Astern	,,	60	44 20	16	14	385	340
21	Ahead	,,	85	44 50	18	19	345	312
22	Astern	,,	60	45 20	15	12	325	287
23	Ahead	,,	85	45 48	18	17	295	272
24	Astern	,,	60	46 19	33	13	255	225
25	Stop	—	—	46 58	—	—	—	—

* In carrying out Order No. 18, the Starboard engine failed to fire when put on to fuel; this caused a drop in pressure from 280 to 237 lb. per square inch not shown in the Table.

condition. The displacement of the ship during the trials on the voyage from Swansea to Liverpool was 7,400 tons, trimmed 3·4 ft. by the stern. The model results have been corrected for this change by plotting values of $\text{(C)} = \frac{\text{E. H. P.}}{\text{Displacement}^{\frac{2}{3}} \times V^3}$ on a displacement base for a number of similar forms which had been tried at several draughts. These gave a clear indication of the change with displacement, and a (C) modified in this way has been used for calculating the naked effective horse-power. The vessel was fitted with twin bossings and rudder, which were not fitted to the model, and was two months out of dock; the former would add about 5 per cent. to the resistance and the latter an unknown amount, the bottom being somewhat foul. The wind resistance at the higher speed (Trial I) can be taken as an additional 6 per cent., and in Trial II the wind resistance was negligible.

"Owing to the difference in the draught at which the tests of the model were made, and that at which the trials of the ship were carried out, a close comparison of the model and ship resistances is not possible. However, in the sea trials the propellers were working under conditions which sufficiently resembled those under which the model was tested, to enable a reasonable comparison to be made, and the thrust, T, of the screw and its $\frac{T}{V^2}$ value at any slip, should therefore compare with those deduced from the model experiments. Assuming that the ship and the model have the same wake factor, the slip behind the ship is defined by the value of $\frac{V \times 101\frac{1}{3}}{P\,N}$, where V is the ship speed in knots, P is the pitch of the propellers in feet, and N is the trials. No allowance has been made in these figures for any departure in wake factor which the thrust data have suggested.

"The foregoing results are summarized in Table XXX, and for clearness the torques obtained from the engine data have also been added. The torques in line (*a*) should agree with the torques in line (*b*), and those in line (*c*) should exceed these by about 2 per cent., which represents the loss in the tail-shaft and journal bearings. The torques in line (*d*) should agree with line (*e*), and exceed those of lines (*a*) and (*b*) by the amount necessary to overcome the friction of the thrust-block and five journal bearings on each shaft. As, during the trials, all the bearings and both thrust-blocks were quite cool to the hand, the losses in this direction cannot be large."

Starting-air consumption trials were made, five out of nine reservoirs being employed, the available capacity being 350 cub. ft. The number of starts possible on one engine, with an available pressure of 490 lb. per square inch in five bottles was 26, equivalent to 23 starts for both engines with all reservoirs in use. The average quantity of free air used per start was 305 cub. ft. The lowest bottle pressure at which the engines started up was 160 lb. per square inch.

Trials were carried out "to determine the rapidity at which the engines could be manœuvred and the ability of the manœuvring air-compressor to meet the demands made upon it. The manœuvring air-compressor was therefore used in charging the reservoirs throughout the test. The last ten orders in the series, which were given at ½ minute intervals, were followed by a period of running ahead to determine the slowest speed at which the engines would run satisfactorily. The above Table XXXII gives the observations of the test as recorded in the engine room. From order No. 1 to No. 18 five bottles only were used; for the remainder all nine bottles were used. At both Order Nos. 11 and 12 a period of 1 minute was allowed after full speed had been attained, in order that the ship should gather way, and to ensure that the next manœuvre should be made under average working conditions."

Slow speed tests were made starting with neither engine working. In both cases a steady low speed was soon reached. In one test the revolutions for the last 10 minutes averaged 37·0 p.m. for the port engine and 40·6 for the starboard engine. In another test the revolutions during the last 5 minutes run were 33·6 p.m. for the port engine and 36·8 for the starboard.

The report concludes with an acknowledgment of facilities and assistance afforded, and with an appendix describing the Moulin torsionmeter which formed the subject of an illustrated article in our issue of June 13 last (see page 764).

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology was held in the Coal Gas and Fuel Industries Department of the University, Leeds, on Wednesday, November 19, 1924, the President, Colonel S. C. Halse, being in the chair. Four papers were presented. The first, entitled "*Note on the Glasshouses of the Leeds District in the 17th, 18th and early 19th Centuries*," by Francis Buckley, was purely historic. He stated that John Houghton wrote in 1691 that there were then three glasshouses in Yorkshire, one near Ferrybridge, and two near Silkstone. They could now identify these as the glasshouses at Houghton, Bolsterstone and Silkstone. The only glasshouse actually in or near the town of Leeds in the 18th century was known as the Engine Glasshouse, and this was probably the factory that supplied all the ordinary needs of the town for the greater part of the 18th century. The Engine Glasshouse might have been the present as well as the predecessor of the famous Hunslet Glass Works, though the connection had still to be proved.

The second paper, entitled "*A Striking Instance of Fireclay Corrosion through the Action of Saltcake*," was contributed by Professor W. E. S. Turner. It stated that during the emptying of a glass tank the fireclay blocks surrounding the dog-hole in a bottle-glass furnace began to swell and to flow, soon after they became exposed to the action of the flame, as the tank was drained. There was a suspicion that when the tank was started a charge of saltcake had been put into the dog-hole, under the belief that the blocking of the hole would be prevented. After examination it was found that the exposed portion of the blocks had absorbed saltcake at an early stage in the operation of the furnace, and being covered with glass and the dissociation temperature very high, the saltcake had remained unattacked until contact with the flame during the emptying of the tank brought about decomposition.

The third paper, "*A Note on Some Properties of a Sandstone Block after Use in a Glass Furnace*," was by Mr. H. S. Houldsworth. It described experiments in which refractory material (Penshaw stone) and glass were ground separately until they passed a 100-mesh I.M.M. sieve, and were then thoroughly mixed in the desired proportions. A little gelatine solution was added, and cones were shaped from the mixture. These were then heated alongside standard sugar cones in a gas-fired laboratory furnace. The results obtained indicated that powdered Penshaw stone interacted as readily with a soda-lime glass as did powdered or good fireclay bricks. Penshaw stone developed a close compact structure when used in a glass furnace. This tended to hinder the penetration of glass into the stone, thus adding to the life of the refractory, and pointing to its successful use in furnace construction.

The last paper, "*The Production of Colourless Glass in Tank Furnaces, with Special Reference to the Use of Selenium, Part IV. The Influence of Arsenious Oxide*," by A. Cousen, M.Sc., and Professor W. E. S. Turner, D.Sc., referred to previous work by the authors, which had shown the great influence of arsenious oxide in preventing the development of colour in a selenius decolourised glass. It was evident that some of the effect was due to the action of the oxide upon the iron present. In confirmation of this fact meltings of a glass batch with addition of various quantities of arsenious oxide were made, and the colour of the glass was found to be less the more of the oxide there was in the batch. This, then, was the first important effect of arsenious oxide in decolourising; the second consisted in the suppression of the brown selenius colour. From this point of view selenium and cobalt oxide were only secondary materials in the decolouring process. The pink colour due to selenium was developed at the commencement of melting. An attempt to replace arsenic by its equivalent of phosphorus in the form of calcium phosphate showed the latter substance to have little or no effect upon the brown selenium colour. Antimonious oxide used with selenium gave a deep bluish green colour.

HYDRAULIC OVERHUNG-TYPE PLATE PRESS.

CONSTRUCTED BY MESSRS. RICE AND CO. (LEEDS), LIMITED, ENGINEERS, LEEDS.

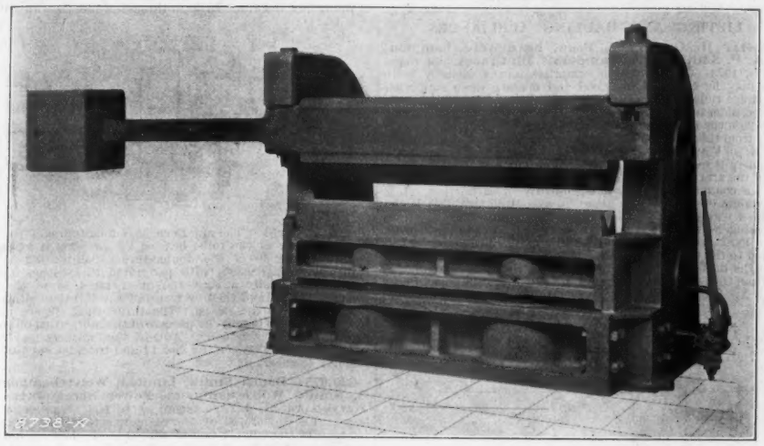


FIG. 1.

Fig. 2.

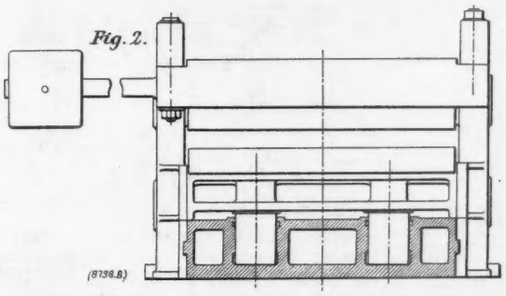
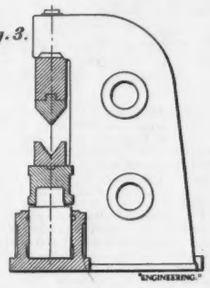


Fig. 3.



HYDRAULIC BENDING PRESS.

THE overhung type of hydraulic plate bender, shown in Figs. 1 to 3 above, has recently been constructed by Messrs. Rice and Co. (Leeds), Limited, of Neville Works, Leeds, for carrying out, in the cold, such operations on light metal sheets as putting flanges on edges or turning the latter up to form square boxes or tanks. The base of the machine is a heavy casting, and contains two cylinders in each of which a ram of 11½ in. diameter is accommodated. The rams are fixed to and support a movable table which carries the steel V-block constituting the lower die, the whole being guided throughout the stroke of 10 in. by lugs projecting from brackets on the end standards. These standards are bolted to the bed, substantial gibs being arranged to take the working thrust of 130 tons applied to them through the upper die and high-carbon forged steel top beam.

This all-steel construction of the beam is adopted to permit of sufficient strength being attained with small depth, this condition being a necessity to permit of the working of sheet metal into boxes of the small size of 1 ft. 6 in. side, a primary purpose of the machine. The beam hinges on one upright and is locked to the other by a bolt.

A weight carried at the end of an extension of the beam serves to balance it when swinging. Should a plate be inserted between the dies and successively bend by pushing it in a number of times it will surround the top beam. It may be removed by pivoting the beam round the vertical hinge and taking off the bent plate endwise. The press is controlled by means of the makers balanced piston type working valve, actuated by a single lever. In Figs. 2 and 3 the various constructional details referred to will be noticed. Plates of any length and up to 7 ft. in width, can be bent by passing them between the uprights.

CATALOGUES

Cowls.—A priced catalogue of revolving cowls for smoky chimneys is to hand from Messrs. Ewart and Son, Limited, 350, Euston-road, London, N.W.1.

Centrifugal Pumps.—A catalogue dealing with centrifugal pumps for low and medium heads has come to hand from the Mirrlees Watson Company, Limited, Scotland-street, Glasgow.

Oil.—Messrs. Ragosine and Co., 161, Bow-road, London, E., have issued a pamphlet containing notes on the properties and cost of lubricating oils and engine-fuel oils. The pamphlet is marked price 1*s.*

Roller Chains.—The Coventry Chain Company, Limited, Coventry, have issued a booklet giving particulars of heavy roller chains suitable for motor vehicles. Practical notes on lubrication, spare parts and tools and methods of repair, are also included.

Fans.—Messrs. James Keith and Blackman Co., Limited, 27, Farringdon-avenue, London, E.C., have issued a separate catalogue of boosting, exhausting and blowing fans with belt, electric or steam-turbine drives. Prices are stated and useful capacity tables are given.

Asbestos.—An account of the development of the asbestos industry has been issued in pamphlet form by Messrs. Bells United Asbestos Co., Limited, 59½, Southwark-street, London, S.E.1. The text, which is reprinted from some articles in the *India Rubber Journal*, contains much useful information.

Electrical Fittings.—Circulars describing an adjustable arm fitting for carrying an electric lamp, suitable for machine tool operators, clerks, draughtsmen, &c., and an electrically-heated glue pot without water jacket, have been received from Messrs. Purit Specialties Limited, Park-street, Birmingham.

Condensing Plant.—A catalogue showing condensers of the central-flow surface, multiple-jet and barometric-jet types, condensate high-lift extraction pumps, and Leblanc rotary air pumps and ejectors, is to hand from the Metropolitan-Vickers Electrical Company, Limited, Trafford-park, Manchester.

Switchgear.—A new edition of their catalogue of switchgear for power houses and sub-stations has been issued by the English Electric Company, Limited, Queen's House, Kingsway, London, W.C. This edition supersedes that of April, 1923, and contains a number of new illustrations and diagrams.

Electric-Light Fittings.—A catalogue of all the necessary fittings for lighting streets, works, ships, mines, shops, &c., is to hand from the Engineering and Lighting Equipment Co., Limited, St. Albans, Herts. A vibration-absorbing fitting, which allows the use of gas-filled lamps under severe conditions, is dealt with in the catalogue.

Propellers.—Information as to the most suitable propellers for small craft is rather difficult to obtain, and Messrs. John I. Thornycroft and Co., Limited, Smith-square, Westminster, London, S.W.1., have issued a special catalogue illustrating many forms and offering to advise owners on receipt of particulars of the boat and engine and of the speed desired.

Suction-Gas Plant.—A catalogue of suction-gas plants, with capacities ranging from 5 to 500 brake horse-power, is to hand from the National Gas Engine Company, Limited, Ashton-under-Lyne. The construction and action of the gas generator and cleaner are clearly described. These plants are intended to use anthracite, gas coal, coke or charcoal as fuel, and contain numerous improvements in detail which facilitate operation and reduce repair costs.

Milling Machine.—A catalogue received from Messrs. Midgley & Sutcliffe, Bradford, of a universal milling machine, shows a machine capable of a large variety of work with twelve spindle speeds, stepped-pulley belt drive, and all the usual facilities. The price is stated, and prices are also quoted for machine vice, turntable plate, vertical milling bracket, and dividing heads made to suit the machine.

Lathes.—We have received from Messrs. George Swift and Sons, Limited, Halifax, a catalogue of lathes ranging from 10½-in. centres to 20½-in. centres, and giving a complete general specification and a detailed description of the gear box, gears and taper-turning attachment, with numerous illustrations. These lathes are well designed and equipped for heavy, accurate work of a general character, including screw-cutting.

Portable Pumping Set.—A pumping set, comprising a petrol engine and pump mounted on a four-wheeled truck, is illustrated in a leaf catalogue received from Messrs. J. W. Brooke and Co., Limited, Lowestoft. The engine develops eight to ten horse-power, and the pump output is 600 gallons per minute against manometric heads of 20 ft. or 30 ft. A pulley for driving machinery by belt is fitted in addition to the flywheel.

Mechanical Stokers.—A new edition of their catalogue of chain grates with a full description and many illustrations of their application to water-tube boilers, has been issued by Messrs. Edward Bennis and Company, Limited, 28, Victoria-street, London, S.W.1. These grates are suitable for use whether the draught is natural, induced or forced, or on the balanced system. The whole installation including mechanical stokers and coal and ash-conveying plant is carried out by this firm.

Sisal-Hemp Decorticating Machinery.—A catalogue of sisal-hemp decorticating machines, issued by Messrs. Robey and Co., Limited, Lincoln, is prefaced by a general article on textile fibres by Mr. Alfred Wigglesworth. The firm's decorticator machines are made with automatic crushing, feeding and other gear, and are capable of dealing with about three tons of fibre in a ten-hour day, requiring 60-h.p. for driving; the dressing machine deals with 10 cwt. of fibre per hour. Baling machines, pumps, engines, railway equipment, &c., suitable for the industry are also described in the catalogue which is of considerable interest.

High-pressure Turbine Pumps.—The application of electrically-driven centrifugal, or turbine, pumps for maintaining the pressure in hydraulic services is explained in a special catalogue issued by Messrs. Mather and Platt, Limited, Manchester, who have supplied a number of sets to replace ram pumps. The list of these sets shows delivery capacities of 200 to 1,000 gallons per minute, maintaining pressures of 400 lb. to 1,500 lb. per square inch, the most usual pressure being about 750 lb. per square inch. The pressure fluid is supplied without violent pulsations, and the catalogue discusses means for automatically regulating the power consumed by the pumps in accordance with the variations in the demand for hydraulic power. The catalogue will be of particular interest to engineers in charge of hydraulic pressure installations in dock, railway and general industrial establishments.

Refrigerating Machinery.—Messrs. Seagers Limited, Dartford, Kent, have sent us a copy of their catalogue of CO_2 refrigerating and ice-making machinery, which includes a full range of belt-driven, motor-driven and steam-driven machines, of both vertical and horizontal types, for land and marine service. The catalogue explains the principles of mechanical refrigeration, giving diagrams of the circulation system and illustrated descriptions of the principal mechanical details of the plant. Complete refrigerating sets are fully dealt with and particulars are given of portable cold stores, open-air condensers, gun-metal fittings, brine grids, valves, leathers, packings, and pressure and temperature-indicating instruments. Compressors for general industrial purposes requiring the compression or liquefaction of gases are also referred to in the catalogue, with which we received a pamphlet reprint of Mr. Henry Brier's paper on pre-cooling read at the fourth International Congress of Refrigeration in London, in June last.

THE ROYAL TECHNICAL COLLEGE, GLASGOW.—We have received from the Director of the Royal Technical College, Glasgow, a copy of the Annual Report on the 128th Session, from which it is evident that progress is being continuously made in this, the oldest technical college in the world. From the report we note that Dr. James Mackenzie has been appointed Chairman of Governors in succession to the late Sir George Beilby, F.R.S., in whose memory it is proposed to establish an annual award in the Department of Chemistry. During the session 1923–24, the total number of students was 4,816. The greatest development in the work of the college is shown in the Departments of Mechanical Engineering under Dr. A. L. Mellanby, Chemistry under Dr. Thomas Gray, and Electrical Engineering under Dr. S. Parker Smith. The recent gifts of plant by the leading members of the British Electric and Allied Manufacturers' Association to the Department of Electrical Engineering is acknowledged in the report, and is a gratifying recognition of the valuable work done in this section of the activities of the College.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

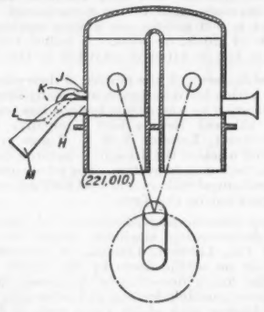
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

GAS ENGINES, PRODUCERS, HOLDERS, &c.

221,010. William Beardmore, Lord Invernairn, Westminster, London, and A. E. L. Chorlton, Westminster, London. Internal-Combustion Engines. (1 *Fig.*) June 2, 1923.—The invention relates to multi-cylinder internal-combustion engines operating on the two-stroke cycle of the kind in which auxiliary exhaust ports are provided which are uncovered by the piston before the main exhaust ports, the exhaust products from the auxiliary exhaust ports being adapted to exert an ejector



action on the main exhaust products. According to the invention a separate passage K leads from the auxiliary exhaust port J, of each cylinder to an ejector nozzle L so disposed in the passage M leading from the main exhaust port H of one of the other cylinders as to exert an ejector effect and thus facilitate and expedite the flow from that cylinder of the products of combustion and the entry into the cylinder of the charge. (*Accepted September* 10, 1924.)

HYDRAULIC MACHINERY.

220,231. Ransomes and Rapier, Limited, Ipswich, and P. D. Ionides, Ipswich. Sluice Gates. (2 *Figs.*) January 25, 1924.—The invention relates to vertically sliding sluice gates of the free roller type. The gate comprises a skin plate A supported by horizontal girders connected at either end to vertical end beams B. The beams are mounted to slide in lateral recesses comprising castings built into the side walls of the channel. The rollers D are mounted to roll on the downstream side of the groove or casting, engaging on the one hand the downstream flange B1 of the end beam and on the other hand a roller path D1 carried by a rib D2 formed on the casting. Hitherto, although a shield plate such as E has, in some cases, been provided to enclose the lower downstream end of the groove, the water of the stream has been free to circulate, as shown by the arrows in Fig. 1, in the groove and has thus set up vibration in the rollers and their paths. According to the invention, not only is the shield plate carried up to the full height of the gate and further extended in an upstream

Fig. 1.

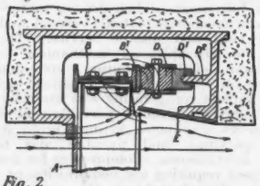
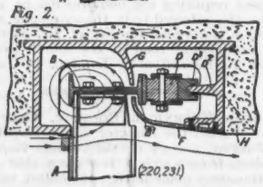


Fig. 2.



direction so as to lie close against the web of the vertical end beam, as shown at F in Fig. 2, but, in addition, a vertical wall G is provided which, together with the shield plate, forms a chamber for the rollers and their paths, and thus separates these rollers from the open portion of the groove containing the main portion of the end beam. Preferably the web of the end beam is somewhat extended, as shown in Fig. 2, so that the edges of the shield plate F and wall G can be brought close up against this web, leaving only a sufficient clearance to permit of the lateral movement of the gate. A suitable "washout" opening, which may normally be closed, may be formed in the base of the chamber. With such arrangement, instead of the water of the stream being free to circulate and thus to vibrate and possibly damage the rollers, as hitherto, the moving water of the stream can circulate only around the main portions of the end beam, as will be seen from the arrows in Fig. 2, the shape of the wall G and shield plate F facilitating the discharge of such water downstream, and minimising any tendency which the stream might have to enter the chamber containing the rollers. Since, however, the dimensions of the slit or opening into the chamber through which the web of the end beam projects, are small relatively to the cross-sectional area of this chamber, the relatively large volume of water contained in the chamber will be undisturbed by any water which may impinge against the slit, so that the rollers and their paths always lie in a stationary column of water, and thus are protected from vibration and damage. (*Sealed.*)

LIFTING AND HAULING APPLIANCES.

220,411. H. G. Taylor, Penn, near Wolverhampton, and A. P. Smith, Wolverhampton. Jib Cranes. (4 *Figs.*) June 8, 1923.—The invention comprises means whereby a jib crane may be arranged to travel and operate when supported by a single runway, even though the jib be used for lifting loads at a considerable distance to one side of the track. A is a runway on the bottom flange of which runs the supporting trolley B and from this is suspended the jib crane consisting of a table D, cage E, jib F and shorter arm G. At the outer end of the arm F is a pulley H over which the lifting cable T passes. At the outer end of the arm G are two grooved wheels J, K mounted to turn about a common axis, but independently of each other. L is a pendulum pivoted to turn about an axis M on the table D and provided with a heavy casing N acting as the weight. Within the casing N is an electric motor, reducing gear, winding drum and a loose grooved pulley. The end of the lifting cable T is secured to the winding drum and is wound thereon by the motor. From the drum the cable passes up over the grooved pulley K and from thence down and around the loose grooved pulley in the casing N. From this pulley it passes up over the pulley J and from

Fig. 1.

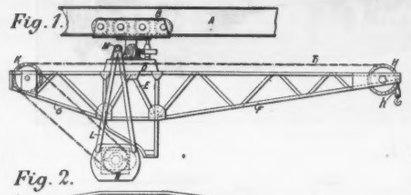
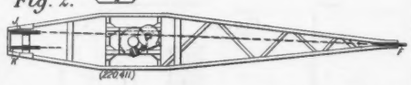


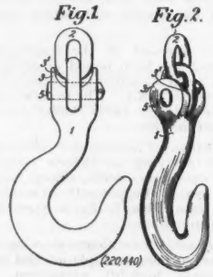
Fig. 2.



thence over the pulley H and is provided with the usual lifting hook on its free end. An electric motor is provided for rotating the jib crane in relation to the trolley B. Assuming that it is required to lift the load, the motor is rotated in a direction to unwind the drum and the hook h to descend to be connected to the load. The motor is then run in a direction to wind the cable on to the winding drum. Assuming the load has any considerable mass, the first effect will be that the pendulum L will move outwards, because the weight of the load will produce a re-acting force which is greater than the re-acting force of the pendulum and consequently the latter will continue to move outwards until the forces become equal, in other words, until the pendulum obtains a moment about the point of suspension of the crane approximately equivalent to the amount of the load about such point. The load will then be lifted while the pendulum remains swung out and the jib of the crane will remain approximately horizontal. On reversing the drum, the load will be lowered while the pendulum still remains in its outward position; but, as soon as the load reaches the ground, further unwinding of the drum will allow the pendulum to move back to the vertical position. (*Sealed.*)

220,440. H. Morris, Loughborough, and J. A. Butterworth, Loughborough. Lifting Hooks. (4 *Figs.*) July 23, 1923.—The invention relates to means by which chains are attached to lifting hooks. In accordance with the invention, that portion of the hook 1 to which the chain 2 is attached, is formed with integral projecting portions 3 so spaced as to

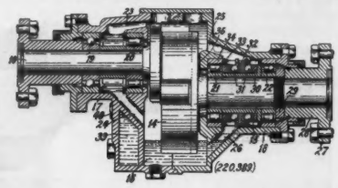
Fig.1 Fig.2.



accommodate snugly between them the terminal link of the chain, and with oval or other holes for the passage of a pin 5 through them and through the link, which pin serves to retain the link in position, while the end faces 31 of the projecting portions are so curved as to conform closely to the shape of the adjacent link of the chain. (*Sealed.*)

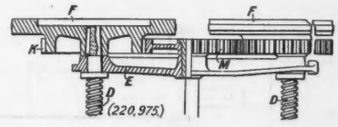
MACHINE AND OTHER TOOLS, SHAFTING, &c.

220,389. L. Burn, Uppingham, Rutland. Speed Reducing Gears. (2 *Figs.*) May 17, 1923.—The invention relates to speed-reducing gears of the type in which the driving is effected by means of two cranked arms on one member engaging with diametrically disposed slots in the face of a disc on the other member. The gearing is, according to the invention, enclosed in a casing of which the main body 16 is substantially cylindrical and constitutes an oil well wherein the disc 14 rotates. On each end of the casing 16 there is provided a smaller portion 17, 18, respectively, which carry the bearings for the driving and driven-shafts 10,15. The driving-shaft 10 is provided with a ball-bearing 19 and a roller-bearing 20, and the driven-shaft is provided with two roller-bearings 21, 22. The portion of the casing 17 containing the bearings for the driving-shaft is provided at its upper side with a conduit 23 which communicates with the upper part of the cylindrical casing 16, and a similar passage 24 is provided extending downwards from the bearing and communicating with the lower part of the casing 16. Similar passages 25, 26 are provided for the bearings of the driven-shaft 15. The lubrication of the bearings is effected by the disc 14, which, during its rotation, picks up oil from the bottom of the casing 16 and scatters it round the upper portion thereof. This oil passes by means of the passages 23, 25 to the bearings for the two shafts so as effectively to lubricate them, the excess oil draining back into the oil well through the passages 24, 26, respectively, so that a continuous circulation of oil is maintained. The casing for the bearings also provides a thrust-bearing for driven-shaft 15. The flange coupling 27 for the driven-shaft is formed with a sleeve 28 which enters the end of the portion 18 of the casing and there engages through a nut 29 with a double-



thrust-bearing 31. The nut 29 engages longitudinally the end of the inner race of the roller-bearing 22, pressing it against the flanged sleeve 30 of the double-thrust ball-bearing 31. The thrust-plate 32 engages with perforated thrust-rings 33 which bear longitudinally against the outer races 34 of the roller-bearings 21, 22, and thereby transmit the thrust in either direction directly to the casing. The thrust-rings 33 are provided with openings to permit the passage of the lubricating oil from the channel 25 to the bearing. Anti-friction washers may be provided, as at 35, between the disc 14 and the adjacent part of the casing. (*Sealed.*)

220,975. Daniel Smith, Limited, Wolverhampton, and D. Smith, Wolverhampton. Power Screw Presses. (4 *Figs.*) April 27, 1923.—According to the invention, a power screw press is operated by two or more screws D, each of which (or each of the outside two of which) is provided with a disc F of a diameter sufficient to cause it to act as a fly wheel to take



the reaction of the pressure. Each of the discs F, F has integral therewith a toothed wheel K and coupling the two wheels together is a toothed wheel M mounted so as to revolve on the bracket E and moving up and down therewith. The discs F, F act as fly-wheels so that, at the moment when the pressure comes on, the reaction is taken by the discs and is not transmitted back through the spur wheels. (*Accepted September* 10, 1924.)

MINING, METALLURGY AND METAL WORKING.

220,457. Cannock Chase Colliery Company, Limited, Chasetown, near Walsall, and H. J. Poynton, Hednesford. Coal-cutting Machines. (3 *Figs.*) August 9, 1923.—In certain coal-cutting machines a cutter chain is mounted on a movable radial arm at one end of the machine, and the hauling gear by which the machine as a whole is moved along the ground is arranged at the other end of the machine. The hauling drum is operated mechanically from a driving motor through ratchet and pawl mechanism, and the radial arm is manœuvred by hand-operated ratchet and pawl mechanism. The object of the invention is to enable the radial arm to be operated mechanically. The body of the machine is indicated by *a*. The usual radial arm and chain cutter are mounted at *b*, but are omitted from the drawing. This arm can be moved around the pivot post *c* by a quadrant or worm wheel *d*, which is engaged by a worm on

Fig.1.

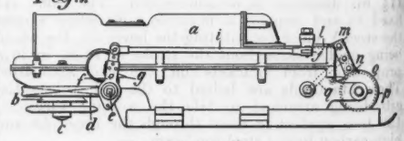


Fig.2.

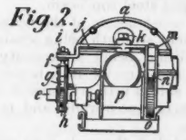
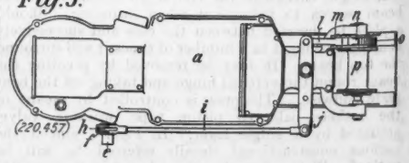


Fig.3.



the spindle *e*. In carrying the invention into effect, the usual hand lever which is mounted on the outer end of the spindle *e* and is used to move the radial arm is shortened or replaced by a shorter lever *f*. This lever carries a pawl *g* which co-operates with a ratchet *h* on the spindle *e*. To the outer end of the lever is attached one end of a link *i* which is further connected at the other end to a lever *j* mounted transversely across the upper side of the machine. The lever *j* is connected by a link *l* to the outer end of the lever *m* which carries a pawl *n* engaging with the ratchet *o* on the hauling drum *p*. As formerly this lever *m* receives its motion from a connecting rod *q* attached to a crank disc which is driven by the main motor on the machine. To operate the radial arm the pawl *n* of the hauling mechanism is put out of action, and motion is transmitted from the motor through the mechanism above described to the ratchet and pawl mechanism of the radial arm. (*Sealed.*)